

Improving the Learning Experience of Decision Support Systems in Entrepreneurship with 3D Management Simulation Games

By

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Abstract

Business simulation games are used in educational institutions and various industries in the private and public sector to train students and employees to practice the principles of management and decision-making skills by providing a fail-safe environment and enabling them to reflect on their simulation results. These games are generally advanced multiuser environments where a user, or a group of users, have access to a virtual company for making business decisions. Some of these games are expensive and their licences are time limited; typically, such a licence is only valid during the duration of the course. In general, these games are not available for the public as part of informal instructional courses.

In Canada, teaching informal courses to immigrants and refugees, which involve data-driven decision making, to prepare them for future challenges they might encounter as business owners, can be challenging; especially considering language barriers and non-business-related backgrounds obtained outside of Canada. Furthermore, based on their decision-making styles, cognitive limitations, and past experiences, people may have an inaccurate perception of the problem or challenge they face, this could lead to poor decision making of the team they are part of and, therefore, this could reflect in the effectiveness of an organization as a whole.

The objective of this research is to enrich current teaching tools in decision-making processes in entrepreneurship courses for newcomers in Canada with a comprehensive and visual representation of operational business problems involved in Business Intelligence and data analytics. More specifically, we designed and developed a 3D Business Simulation Game with randomized scenarios using modern technologies, such as Unreal Engine as the game engine; Adobe Fuse for the character creation, Mixamo for animation of the character, and Substance Painter for textures and materials for the assets.

The research was conducted with the participation of the students of the Business Creation and Project Management course at VIRCS (Victoria Immigrant and Refugee Centre Society) where we tested this game on each one of the five units of the course. After designing, developing, and testing the 3D business simulation game, we conducted a comprehensive evaluation to investigate whether the decisions students made while playing were correct or not. We also evaluated whether they felt that the challenges were easier to understand, both as a team and individually, when they used the 3D business simulation game compared to only the written description of the problems.

The main results we obtained from our study are the following: After playing the business simulation game, students became more aware of the importance of making correct decisions in different business scenarios. They made sure that the whole team understood the problem, and they felt generally good about their understanding of the course content. We also noticed that when the animation was not part of the business simulation game, they seemed to be confused when following written instructions. This indicates that they depended on the animations for their decision-making.

We believe that, in some ways, the course and the 3D business simulation game we created for this research were a great opportunity to observe students becoming more confident in their future in Canada as entrepreneurs. We observed that, once the game has been used, the students become more participatory in class, the discussion of the course material increases, and in general, the students seem to enjoy the course more.

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Dedication

To the brave newcomers to Canada and to all immigrants and refugees around the world.

To Gabi.

1. Introduction

Kevin Desouza [1] believes gamification and role-playing, common in Operations Research and AI, could be the key to public servants analysing complex cases, arriving at better business solutions, and truly understanding the future of autonomous systems. Solving problems in real time requires a broad mix of skills, knowledge, and capabilities, such as adaptability, collaboration, innovation, and knowledge sharing [2]. The above acervation flows holistically, if there is motivation and self-regulation with the development of possible courses of action, considering that multiple stakeholders may have conflict in the development of both rational and emotional skills. Furthermore, these problems require systematic thinking and adaptive leadership work [3]. Systematic thinking focuses on outcomes and the dynamics of the phenomena under study, such as, potential outcomes, chains of entities, processes, stakeholders, actors, inputs and outputs and all the relationships that may exist among them [4].

Considering the migrant and refugee crisis that the world is experiencing, it is estimated that there will be a much greater increase in newcomers to Canada in the coming years when compared to the past decade. For this reason, it is to be expected that there will be fewer immediate job opportunities for newcomers. Although the Canadian Government is interested to help newcomers, some skilled immigrants to Canada may face the harsh reality of not finding a job that motivates and helps them grow professionally. We believe that, in order to help newcomers adapt to Canada, courses that improve their decision making supported by data, could help prepare them to become more valuable to potential start-up companies. Finding resources and technologies to help teaching newcomers skills to adapt to Canadian standards is of paramount importance. Teaching how to be successful when self-employed could not only help support immigrant families but also create more employment overall.

We believe that new immigrants to Canada must be trained to build an innovative country according to the five steps in the innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation [5].

Some entities in Canada, such as Canada Learning Code, are offering training in specific technical skills like coding and robotics to the general population, including newcomers. While knowledge of these skills is important for the 21st century, practitioners need to consolidate this knowledge towards problem solving, cognitive skills, and critical thinking applied in real life. In cases when the newcomers already bring these skills, they should be well trained so that they can adapt these skills to the requirements in the Canadian labor market. This way, along with these technical skills, newcomers can create solutions that create value for society.

According to Wisdom of Crowds Business Intelligence Market Study by Dresner Advisory Services, 2021 [7], people with training in decision-making processes can be assigned to important projects

within a company, access better jobs or be promoted within the company. The objective of our research is to design and develop a 3D Business Simulation Game with random scenarios that serves as a teaching tool for decision-making processes in the context of business operational problems in entrepreneurship courses for newcomers in Canada. With this research we investigate whether, by using the proposed game, the users will become more adaptable to the challenges that occur in real life, which are typically accompanied by uncertainty of market dynamics in today's modern industries. For this purpose, we evaluated whether challenges are easier to understand, both as a team and individually, when the students used our 3D business simulation game compared to a situation with only the written description of the problems. Furthermore, this research focuses on understanding business problems from a human perspective, when users must make ethical decisions with sustainability in mind.

1.1 Contributions

The intertwined relationship between the manufacturing of products (and / or the provision of services), and economic, social, and environmental aspects make management challenges more complex [6]. Real world problems are usually characterized by their complex value system, multifaceted ramifications, vagueness, and lack of fluidity. Greenfield et al. [7], when referring to teaching undergraduate students to make decisions, indicate the lack on inductive problem solving, critical thinking, and imagination; and those learners who are exposed to business management theories often have difficulty comprehending a business without practice and experience (see also [4]). To the best of our knowledge, There is no research on informal education in the community in Canada, but we assume that teaching newcomer students would have similar results to what Greenfield obtained.

Teaching entrepreneurship to prepare newcomers to Canada, who can have limited knowledge of abstract vocabulary, lack of mindfulness, underdeveloped social relationships, or limited attention, might be more complicated than teaching the theory of Entrepreneurship to undergrad students. Therefore, we believe that without practicing problem-solving and decision making it might be very difficult to newcomers to adapt to industry in a foreign country. As such, the contribution of this research is to create a tool with state-of-the-art technology in the development of business simulation games to help newcomers prepare to face decision making problem-solving challenges [8]. In Experiential Learning Theory, there is a belief that playing while learning is fun for everyone and helps students relax and become familiar with the material to achieve the learning outcomes [9]. More specifically, "It builds brain pathways for thinking, creativity, flexibility, empathy and many other lifelong skills" [10].

We believe that our proposed 3D business simulation game will help students bring their previous professional experience and skills to class, work motivated by the visual effects and acquire a practical understanding that helps them make better decisions. This is also facilitated by the fact

that our game uses less text written in a language that they are not familiar with than more advanced business simulation games. The tool developed for this research represents the real world in a safe environment where there is no risk, where students develop knowledge that is valuable when they participate in simulation games so that in due course they can participate effectively in the real world. Without risks, this virtual experience, as social as it can be, might reduce anxiety in the students while stimulating creativity and thinking [11].

Our game also supports the instructors. When using our 3D business simulation game during their course, instructors are not expected to have to explain the game in detail. They could focus on contributing to the game experience, clarifying course material, providing cognitive support, and enhancing the pedagogical experience. This should give them the opportunity to provide a framework for the introduction of more complex topics and to make it easier to adapt the material to the topics that the simulation works with.

The overarching goal of our research is to improve the outcome of the learning process as knowledge that is not transferred by the instructor alone but “constructed through a service co-production process utilizing various resources in the learning space” [11] with the Experiential Learning Theory through interactions and experiences [12] in a virtual world. The proposed 3D game also aims to expose students to comprehensive ethical challenges and to make decisions based on reaching the United Nations Sustainable Development Goals (SDGs), so that the students are exposed to these concepts before they enter the real world as entrepreneurs.

2. Related Work.

Management games, or business simulation games, are defined by “an activity carried out by cooperating or competing decision-makers, seeking to achieve, within the rules, their objectives” [13]. Advanced games have been made for leadership development [14], complex problem solving [8], supply chain and process optimization [15], and performance measurement [16]. When management games are used for experiential learning, such as the one in this research, the objective is that students develop cognitive, rational and emotional skills that are valuable to business practice [4].

Nanu Challenge. One of the learning tools the students in the “Business Creation with Project Management” course (provided at VIRCS to newcomers) use is a third-party online 3D simulation game, called The Nanu Challenge implemented on Venture Blocks (<https://ventureblocks.com>). This game guides students through the Customer Development Process [17]. Students get instant feedback from the customers, so they can learn from their mistakes. The Customer Development Process that The Nanu Challenge addresses is a four-step framework, originally identified by Steve Blank in his book “The Four Steps to the Epiphany”, to discover and validate that one has (1) identified a need(s) that customers have, (2) built the right product to satisfy that customer’s

need(s), (3) tested the correct methods for acquiring and converting customers, and (4) deployed the right resources in the organization to meet the demand for the product. The free The Nanu Challenge demo (used at VIRCS) presents only a particular situation that covers the first two of the four steps, where the student has very few opportunities to interact with customers in order to perform customer discovery and validation. Although it is a good practice for students to learn what kind of questions are appropriate to ask in order to extract the correct information in the marketing research process, this demo does not bring any information from a decision-support system perspective. In contrast, our proposed game enhances the learning process by presenting the students with challenges that will allow them to make decisions based on data.

Complex Business Games. There are other business simulation games used in undergraduate and graduate schools, such as “Data Analytics Simulation: Strategic Decision Making” by Thomas H. Davenport [18], “Working Capital Simulation: Managing Growth V2” by Sandeep Dahiya [19], and “New Venture Simulation: The Food Truck Challenge” by Michael A. Roberto [20]. These simulations games teach students decision-making using sophisticated analytic techniques in order to understand current issues and determine the best strategy in their business. These games and the many more that are available on the Harvard Business Publishing¹ site in the category of decision-making and entrepreneurship include large blocks of text and many graphs that intend to explain the challenges to solve. These games could not be used in our research because their licenses are too expensive for a community course. They are also quite complex to comprehend and in particular their language is typically too advanced for our students. The challenges presented through these simulation games are a better fit for courses in finance, accounting, small business management, and entrepreneurial finance. They are suited for deeper discussions of innovation, product development, design thinking, lean start-up, entrepreneurship, strategy, marketing, and organizational learning. However, they are not a good fit for new immigrants learning basic business skills.

AI-Based Business Games. On a large and complex scale, in order to mitigate human error in decision making in manufacturing, consulting companies, such as IBM, are offering advanced solutions that involve Natural Language interpretation systems, such as IBM Watson AI². Watson includes AI and the use of IoT to help manufacturing companies make decisions rapidly with the purpose of mitigating uncertainty, predict interruptions, and take actions in their operations. To allow anyone to understand this technology, IBM offers a simulation demo on its website. Industry applications (e.g., visual inspection, acoustic insights, AI assistant, etc.) are examples of industry apps included in IBM’s suite of IoT and Watson AI solutions for industrial businesses described under Industry 4.0. Industry 4.0, which is the digital transformation of manufacturing/ production and related industries and value creation processes. Students who took this course also watched the IBM demo after working on our business simulation game to expose them to advanced

¹ Harvard Business Publishing is an affiliate of Harvard Business School. It provides content for online learning such as brief business cases and simulations <https://hbsp.harvard.edu/coursepacks>

² <https://www.ibm.com/industries/manufacturing/industry-4.0-model-factory/>

applications that they might encounter in the future or that they could adapt once their business is up and running and needs it. We consider the IBM products as complementary to our proposed simulation game, not as competing solutions.

Empathy Map. Several business games, including The Nanu Challenge and in the game developed for this research, make use of the Empathy Map [21], given in Figure 1, which is the ability to understand the needs and feelings of the client with "Empathy". Empathy Map is developed by XPLANE. This tool helps to go beyond customer's demographic characteristics and develop understanding of the environment, behavior, concerns, and aspirations of the customer. Doing so allows us to devise a stronger business model, because a customer's profile guides the design of good Value Propositions, more convenient ways to reach customers, and more appropriate Customer Relationships. Ultimately it allows us to understand what a customer is willing to pay for.

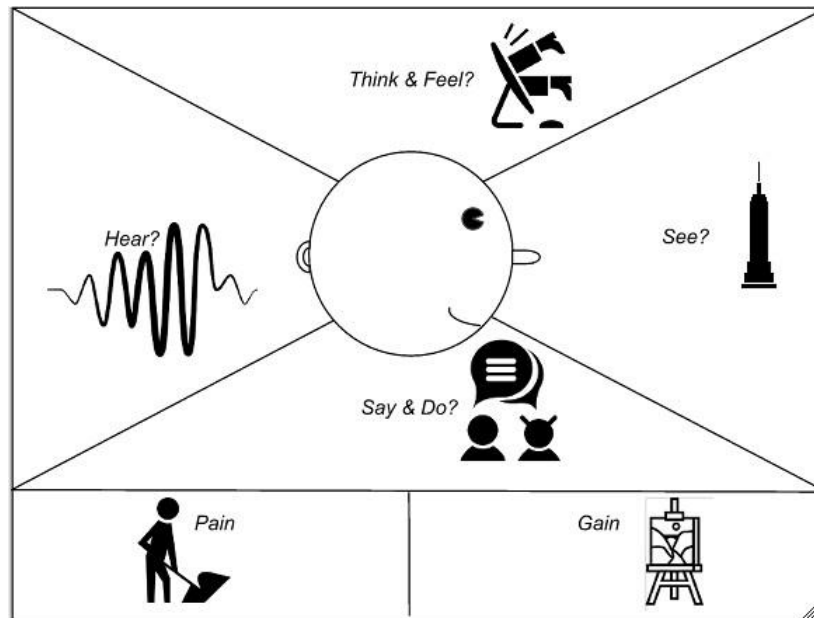


Figure 1 Updated Empathy Map Canvas by Dave Gray, XPLANE.

This work is licensed under a Creative Commons Attribution 2.0 International License. Available at <https://xplane.com/worksheets/empathy-map-worksheet/> <https://www.flickr.com/photos/jimgroom/15421812261>

3. Course-Game Co-Design: Teaching Entrepreneurship to Newcomers to Canada

The course “Strategic Business Development and Project Management for Newcomers”, organized by the Victoria Immigrant and Refugee Centre Society VIRCS³ is offered at the Victoria Public Library, as well as online. The course is offered to any immigrant in Victoria who has a working permit. The objective of this course is to provide newcomers with strategic tools to create and manage their own business under the Project Management framework. The course was designed by the author of this research, Olga Gould. The Project Management module was taught by guest speaker Ivan Rincon, Director, Emergency Management BC, at the BC Provincial Government.

The course is strategically divided into three modules; students work at the end of each module in the proposed business simulation game in order to apply what they have learned. Before describing the game, we provide details about the modules covered in the course and how the proposed game will enhance the students’ learning in each module. Specifically, each module introduces the following business concepts under Entrepreneurship Theory:

- Marketing Research: Students learn how to ask good questions to potential customers, as well as which kind of questions are needed using the Empathy Map. The proposed business simulation game will help students put these skills and knowledge in practice to estimate the demand, the amount of product to be produced and the scheduling on the production line. After conducting the marketing research, the students were to decide the amount of expenditure in advertisement cost, which is expected to increase the demand.
- Operations Management: Students learn how to cope with random changes in amount of demand (and market share), which brings experience on logistics and production control challenges. Operation Management includes resources management, human capacity, production etc. Certain constraints will apply, such as labor capacity, demand, limitations in raw material, and costs of the equipment. The students will also learn about the principles of microeconomics in order to grasp foundational aspects of including supply and demand as well as how the market determines prices. In the business simulation game, students will be presented with optimization problems such as minimizing cost or maximizing the revenue of operations.
- Finance Management and time value of money: Students learn how to deal with Balance Sheet, Cash Flow and Income Statements that change accordingly to the decision making of the business. In the proposed game, the students will be presented with five game years and the above items will change according to the decisions they make. Concepts such as financial ratios will also be present in the game.

Other Entrepreneurship Theory concepts taught in the course that are not included or practiced in our simulation game are Business Registration per type of business, Permits in Canada, Digital

³ The Victoria Immigrant and Refugee Centre Society (VIRCS) is a non-profit organization founded in November 1989 VIRCS provides a wide range of services to its target group, assisting them with everything from settling in Victoria to finding a job. <https://www.vircs.bc.ca/>

Marketing Strategy, Business Model Canvas development, networking, Business Law, and negotiation.

3.1. Meaning of Entrepreneurship

Clarifying the concept of success when teaching entrepreneurship is not an easy task, and neither is how much becoming a good entrepreneur is influenced by the personality of the person, their experience and knowledge, the team dynamics and the organization [22]. When speaking (at UVic) with Dr Robert Gentleman, creator of the programming language R and one of the executives of 23andMe⁴ about correlation between DNA profile and entrepreneurial motivation, he pointed out that he believes that success in entrepreneurship does not depend on the type of person but on the opportunities this person is offered.

In some cultures, the term entrepreneur is used as a synonym of toughness with employees and aggressiveness against competency, capitalism, and superiority [23]. Some scholars use the term loosely, making connections between personal experiences and the experiences others have had to suggest what a person must do to be a successful entrepreneur [24]. The concept of Entrepreneurship we use in our research is a form of living driven by self-motivation, opportunities, free market and increased motivation [25]. The course we teach to Newcomers, where we want to improve the learning experience of Decision Support Systems in entrepreneurship with 3D management simulation games, only teaches basic concepts on entrepreneurship which could be enough to motivate the newcomers to Canada to create their own business.

3.2. Risk Assessment

Teaching about making business decisions intends to help the students consider the different types of risks in data-driven decision making. There are different types of risks we consider.

Intrinsic risk is a random variation of external factors that is beyond explanation based on the data and tools available. This risk is represented in the game by random changes in the market share.

Parameter risk is the risk due to errors in estimating the parameters of the model under the assumption that one is fitting the correct model to the data in the first place.

Model risk is the risk of choosing a wrong model, i.e., in forecasting, making wrong assumptions about whether or not, and how the future will resemble the past.

⁴ DNA Genetic Testing for Health and Ancestry <https://www.23andme.com/en-ca/>

In our game, parameter risk and model risk are faced by students when they make decisions about the price of the product (Cocoa in our case) to be sold to customers. When the virtual company in the game has the highest price per ton of cocoa in the market, the market share will decrease the following year. If the price is too low, the company loses the opportunity to be more profitable than the competition by selling at a higher price. Here, while students must not make drastic changes in the price of the product from year to year, they must also maintain a competitive price.

Intrinsic risk is more complicated and has many facets. For example, businesses can lose market share if they do not advertise as much as the competition does. If they spend more money on advertising than competitors, their demand could increase dramatically. If they do not buy enough equipment next year, to produce enough product to meet demand, then unmet demand will cause them to lose customers, thus losing market share.

There are also other types of intrinsic risk that our business simulation game introduces to users, such as considering the poor quality of data or unreliable sources. Following the principles of Project Management⁵ in organizations which are taught as part of the course, such risks could be mitigated or controlled [26]. There are different decision-making approaches at the individual level that can affect the decisions of the organizations as a whole. For example, cognitive limitations, biases, and past experiences that each individual might have [27]. The dynamics at the group level could also affect the effective decision making. The composition of the group, the group processes, the hierarchical differences among other aspects must all be considered. At the organizational level, the complexity of the system, time pressure and organization policies are factors that generally affect decision-making [28]. There are also external factors that are uncontrollable but by understanding their impact and likelihood, the risks could be mitigated or controlled.

Enterprise Risk Management (ERM) is a plan-based business strategy that aims to identify, assess, and prepare for any dangers, hazards, and other potentials for disaster—both physical and figurative—that may interfere with an organization's operations and objectives [29]. The approach on ERM in practice has five phases to be conducted by the organization or by independent consultants. At the end of these phases the results will show a likelihood and impact assessment of the risks as shown in Figure 2. The figure shows a heat map depicting in red the area where risks can be more likely to happen and at the same time having the most impact on the company. In our business simulation game, the users observe the greatest risks their virtual company is facing by observing the results on dashboards that include the Risk Management Plan Enterprise and Risk Management Assessment which include Likelihood Assessment. The students are also informed about external risks such as export and import agreements of the country where each company is located and changes in commodity prices of cocoa. The groups need to consider these factors as

⁵ According to the Project Management Institute, Project Management is the process of leading the work of a team to achieve all project objectives within established constraints. Students on this course learn that Project Management involves planning and organizing resources to accomplish a specific task, event, or goal throughout the evolution of business creation.

they will likely affect the prices, demand, and the delivery times of their product, which will impact the company performance.

In addition to the Likelihood Assessment, students learn to include in their analysis the Impact Assessment guidelines that separately analyze the severity of the impact by risk category in the business, such as: Financial Resources, Strategic and Reputational Resources, Human Resources, Operational Efficiency and Effectiveness (including IT-related risks), and compliance (Regulatory, security, legal and contractual).

Ranking and Response Framework:							
4 - Extreme	Immediate attention required, risk treatment plan to be developed and monitored.	2 - Moderate	Active monitoring and response procedures required.				
3 - High	Detailed planning and review by senior management.	1 - Low	Managed through routine procedures.				
LIKELIHOOD ASSESSMENT GUIDELINES:			RISK EVALUATION AND PRESENTATION				
>95 %	Almost Certain Occurrence / Very High Frequency Very high probability the risk will occur (multiple times a year), or a very high percentage or frequency of transactions whereby incidents occur.	5					
71% to 95%	Likely Occurrence / High Frequency High probability the risk will occur (once annually), or a high percentage or frequency of transactions whereby incidents occur.	4					
31% to 70%	Moderate Occurrence / Moderate Frequency Moderate probability the risk will occur (once in 2 - 3 years), or a moderate percentage or frequency of transactions whereby incidents occur.	3					
5% to 30%	Unlikely Occurrence / Low Frequency Low probability the risk will occur (once in 5 - 7 years), or a low percentage or frequency of transactions whereby incidents occur.	2					
≤5%	Rare Occurrence / Very Low Frequency Very low probability the risk will occur (once in 10 years), or a very low percentage or frequency of transactions whereby incidents occur.	1					
		Likelihood Impact	1	2	3	4	5

Figure 2 Risk Assessment Framework – Likelihood and Impact Assessment Guidelines

3.3. Ethics and Sustainability

While this research does not intend to provide a deep understanding of the theory of ethics, the goal of the business simulation game is to increase the ethical awareness as a professional and encourage participants to ask the following questions: “What is the ethical landscape of the new challenge I am taking up for my organization or client?” “What are my personal responsibilities and ethical stance as I carry out my work?” “How do I foster greater ethical awareness in the workplaces, organizations and communities I deal with?”

Then, the user will experience challenges based on real case studies to learn about:

- Ethics and social consciousness and their impact on decision-making
- Code of ethics when using strategy steps for solving ethical problems
- Ethical challenges and ability to resolve conflict of interest, risk management and sustainability

According to the Stanford Encyclopedia of Philosophy, Consequentialism is the class of normative ethical theories holding that of all the things a person might do at any given moment, the morally right action is the one with the best overall consequences [30]. Consequentialism is based on two principles:

- Whether an act is right or wrong depends only on the results of that act.
- The better consequences an act produces, the better that act is.

To introduce ethical challenges, the business simulation game uses Creating Horror through Level Design: Tension, Jump Scares, and Chase Sequences introduced by Jared Mitchell [31], which is described in Figure 3. In contrast, in our game, if students fail when solving a business problem, they will be given the reasons and the negative impact on the company.

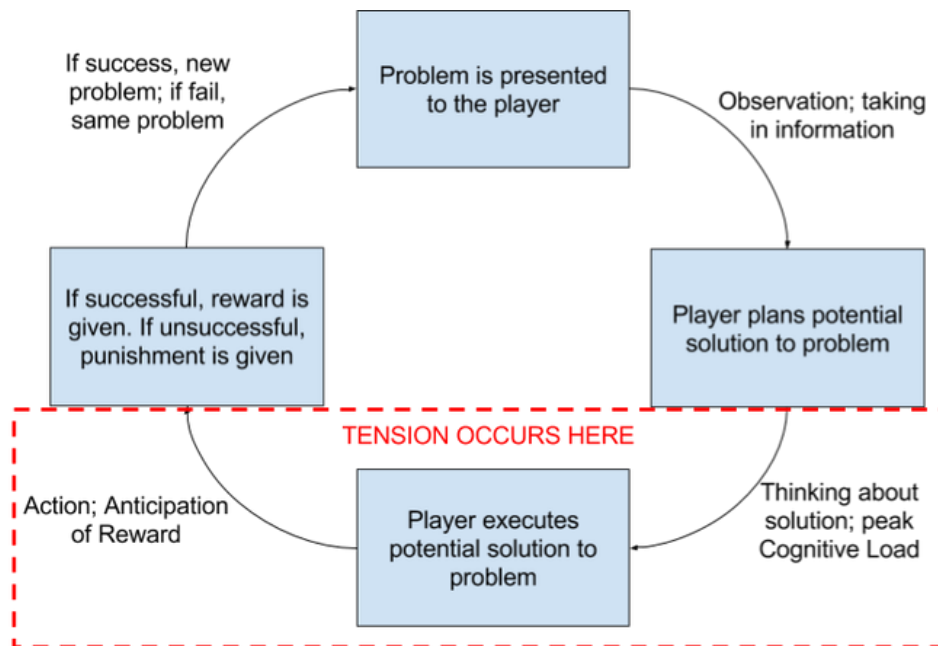


Figure 3 Creating Horror through Level Design: Tension, Jump Scares, and Chase Sequences by Jared Mitchell.

This work is licensed under a Creative Commons Attribution 2.0 International License. Available at <https://forum.wickeditor.com/t/how-to-create-horror-through-level-design-tension-jump-scares-and-chase-sequences/6075>

Our business simulation game also challenges students on sustainability concepts. They must find an optimal production so that the waste generated by the company is minimal, which is equivalent to maintaining a clean production that meets the 12th objective of the United Nations Sustainable Development Goals (SDGs). The United Nations Sustainable Development Goals (SDGs) are targets for global development set to be achieved by 2030. The students learn these concepts in class. In the business simulation game, the students are challenged to make decisions based on reaching these goals.

Referring to goal 12 in Figure 4, wasting raw material is penalized in our game. To have raw material unused means the reputation of the company will be affected, and then the market share will be reduced significantly. Ideally the students must estimate the amount of raw material to supply the demand, without knowing for sure what the demand would be until the end of the year. Also, the user must assign the optimal purchase of raw material from providers that will cause the least harm in data privacy, environment, and labour conditions.



Figure 4 The United Nations Sustainable Development Goals (SDGs).

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3.4. Issues of Legality and Privacy

Automated algorithms are involved in many aspects of our daily life. Algorithms make movie recommendations, suggest products to buy, and are increasingly used by organizations in high-risk decision systems, such as loan applications, hiring [32], [33], and other applications. Unlike people, machines do not wear out as quickly [34] and can handle more multiple constraints than a human. However, algorithms can be vulnerable to bias, which makes their decisions "unfair" [35]. Our game makes sure that the students are aware of these issues when relying on computer generated suggestions. More specifically, in our game, the students are presented with suggestions that arise as a result of automatic data analysis software. Users should recognize that this is a supplement to decision support, not a substitute for their own experience. This is a way

of teaching students to assess whether there is a false sense of security that "the computer knows best".

In order to teach issues of privacy in decision support systems and the data privacy law in Canada [36], in our game, the students are presented with some scenarios where privacy protection considerations must be made. For example, students are faced with such considerations in cases when the data is collected in a way that could help them make good decisions but could damage the reputation of the company because it was made without proper authorization.

To provide some background, the privacy aspect of accessing the data is strongly regulated in PIPEDA - Personal Information Protection and Electronic Documents Act in Canada [37], and in the European Union with the GDPR (General Data Protection Regulation) [38]. Note that, the US does not have any centralized, formal legislation at the federal level regarding Data Protection Law but does insure the privacy and protection of data through the United States Privacy Act, [39] the Safe Harbor Act and the Health Insurance Portability and Accountability Act [40][41]. Even though the students are newcomers to Canada, and they are trained to be entrepreneurs in Canada, they still need to know of privacy laws in other countries, such as the US and countries in the EU. Our game presents participants with privacy considerations involving an international business environment.

Additionally, there is a low adoption of the international standard ISO/IEC 2700 on information security management by organizations [42]. The ISO/IEC 27001 Information Security Management provides some guidance and requirements for an information security management system (ISMS). An ISMS is a systematic approach to managing sensitive company information so that it remains secure. It includes people, processes, and IT systems by applying a risk management process. It can help small, medium, and large businesses in any sector keep information assets secure. Again, the students are taught these standards in class and need to think carefully about them when participating in our game.

To conclude, for the ethical challenges the students need to solve, we intend to teach the newcomers that fairness in automated decisions and protection of privacy of users should be a priority. They must decide what source or material is more adequate to purchase based on sensitive information that the company should or should not be using in order to make decisions by trusting their knowledge and experience rather than automated software.

3.5. Competitive Strategy in a Business Simulation Game

The aim of a simulation is to deepen students' conceptual understanding by working within, and reflecting upon, a representation of a real environment. For example, simulations of the macroeconomy may be used to train economists by requiring them to devise economic strategies to achieve policy objectives. The dynamic of a simulation may be competitive, whereby students are encouraged either to outperform other students or to achieve a high rating according to

criteria set by the simulation. However, students might also be encouraged to explore a simulation, to investigate its behaviour and discover its assumptions. For example, they might be asked to set their own criteria for 'successful performance' within a simulation and then to investigate how best to achieve that performance. In most cases, it is the way in which a simulation is used that determines whether it is effectively a game. This choice has important implications for the way in which a simulation may contribute to learning [43].

For the purpose of creating a healthy and amicable competitive strategy in the course, the students are asked to read the summary of the principles of the book "Sun Tzu and the Art of Business" [44] based on the book "The Art of War by Sun Tzu" [45]. Sun Tzu's key principles that are encouraged to practice during the business simulation game are speed, strategic alliances, secrecy, deception, avoiding your enemies' strengths, and attacking their weaknesses; all without undermining or destroying the competitors.

4. Game Methodology

The business simulation game was structured around three major phases. (1) Pre-play or preparation, (2) play or execution, and (3) post-play or reflection.

In phase 1, all teams learn about the game environment, the operation of the company and its financial structure. In addition, they learn about the type of resources available and the decisions that need to be made. At this stage students develop a group awareness of the strengths and weaknesses of their business.

In phase 2, during the five iterations executed in the game, actions and reactions are activated to respond to challenges that include rules and restrictions, simulating the underlying management context in real operational systems. Each iteration of the game ends when a decision is made, or when the time limit is met. The game collects all the variables decided by the teams and assigns a new market demand to each company. The demand assigned at the end of the game should be considered as the reward of the game. The higher the demand assigned to a company, the more successful the company is. The demand to each company increases if the team maintains a good pricing strategy, spends on advertising, and does not generate waste in production. On the contrary, demand decreases if the price is high compared to the competition, the company is not invested enough in advertising, or if a lot of waste is produced.

In phase 3, the game calculates the value of each company using the Discounted Cash Flow (DCF) valuation method in each of the five runs. The company with the highest value wins the game. The students receive the valuation of all the companies in each iteration, so they understand if they are above or below the competitors. This shows them if they have been taking good decisions on each opportunity.

At the end of each phase a reflection on the experience is given to students to build new knowledge, skills, and abilities. In the following we describe in more detail the above-mentioned phases. See Figure 5.

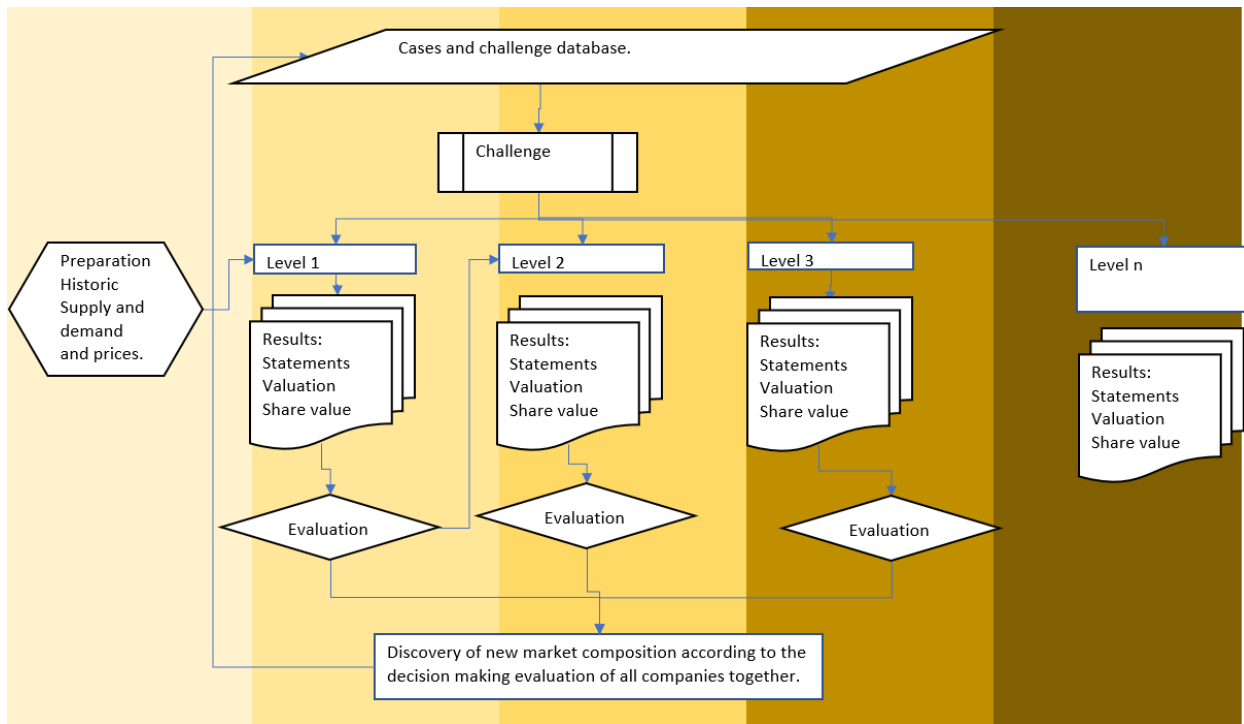


Figure 5 Game Flow

4.1 Storyboard: Business Simulation Game Flow Design

Phase 1

Before the students participate in the business simulation game, they receive a basic financial model of a new cocoa plant that processes cocoa beans. Figure 6 shows the workflow of a typical cocoa plant. In our game we only focus on winnowing, toasting, and grinding. The financial model is based on ten years of financial statements. The statements of the first five years will change depending on the decisions a team makes, whereas the statements of the last five years will be forecasted. The forecast also includes the repurchase of equipment after the depreciation of the assets is complete (see Figures 11, 12, 13). In accounting, the Balance Sheet, Income Statement, and Cash Flow are interconnected as shown in Figure 10.

Variables' initiation

Each company (group of students) starts with the same demand of 6,480 tons of cocoa and a share of capital of \$5,000. In order to produce the 6,480 tons of cocoa, each group needs to purchase

16 Winnowers, 6 Toasters-Roasters and 10 Grinding machines (Figures 7, 8, and 9 illustrate each type of machine). However, the students do not know this; depending on the market share allocated by the game, they must make the decision every year on how many machines of each kind they need to purchase. The cost of each Winnowing machine is \$70, each Toaster-Roaster is \$255, and each Grinding machine \$101. The model itself calculates the cost of the raw material based on the level of production, the number of employees needed in each machine, their salary and compensations.

Now we describe each process as follows.

- **Winnowing.** This is the process of removing the outer shell from the cocoa beans. The capacity of a winnowing machine is 405 tonnes per year.
- **Roasting or toasting.** Various chemical reactions occur when cocoa beans are roasted, and proper roasting is integral to good, flavored chocolate. The vinegar smell from fermenting is driven off. Raw beans do not taste like chocolate. Roasted beans do. The capacity of a roasting machine is 1,080 tonnes per year.
- **Grinding.** A melanger (a grinding machine) is typically used to grind small chunks of roasted cocoa beans called nibs, down into a thick liquid known as chocolate liquor. The capacity of melanger is 648 tonnes per year.

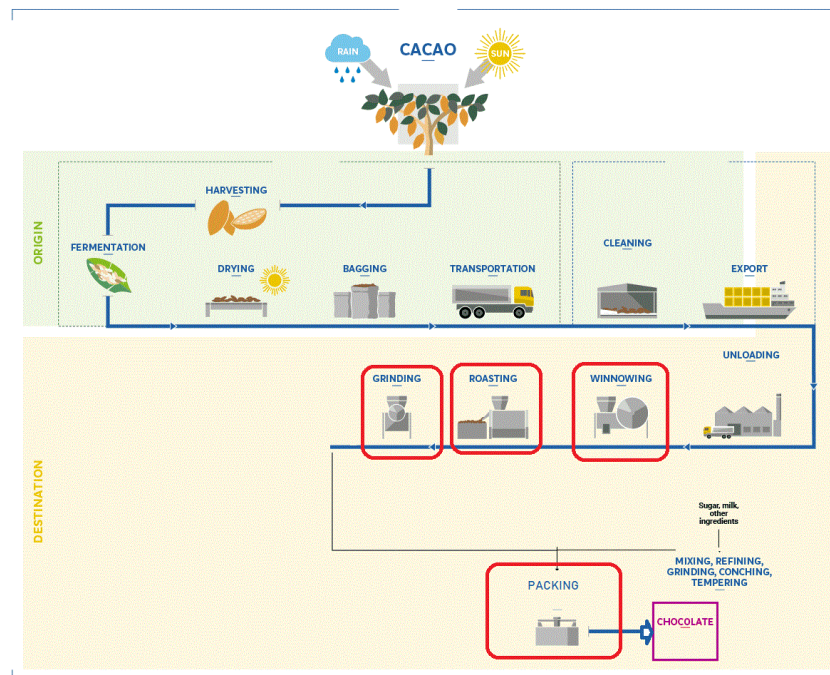


Figure 6 We show the production flow of turning cocoa beans to chocolate. In red we show the sections that are considered in our business simulation game.

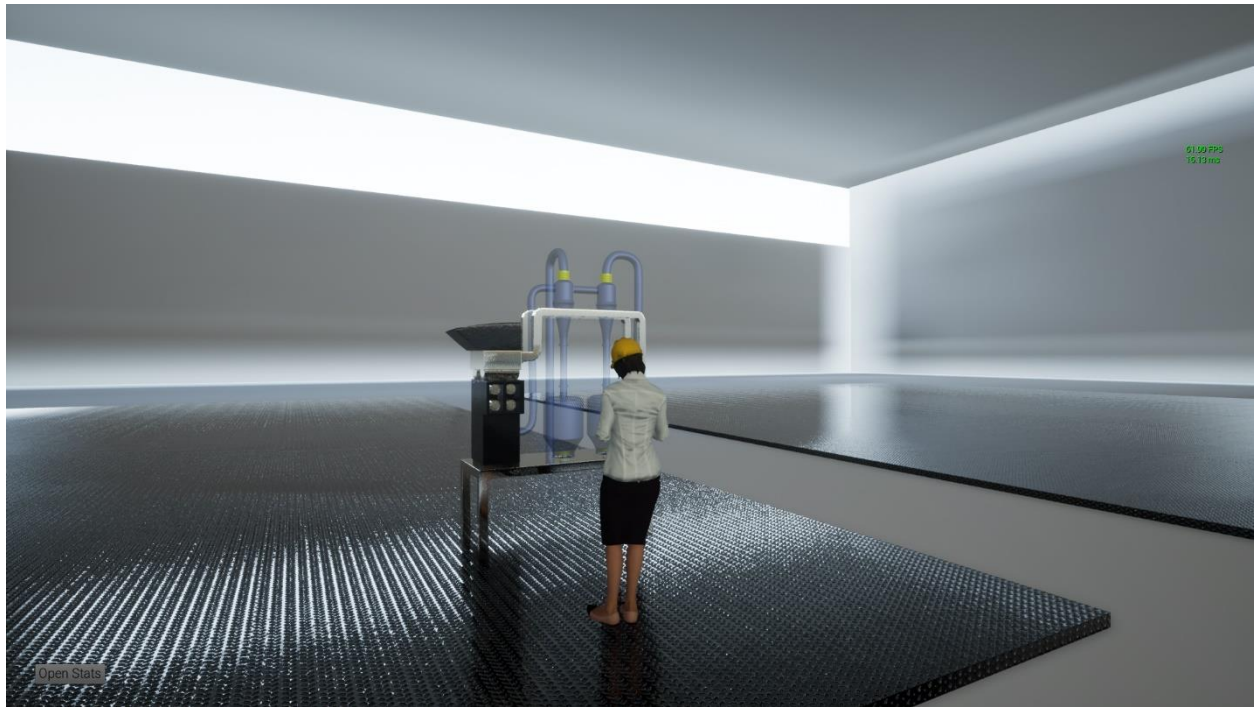


Figure 7 The game character in front of a cocoa winnower. Winnowing is the process of removing the outer shell from the cocoa beans.



Figure 8 The game character in front of a cocoa roaster (toaster).



Figure 9 The game character in front of a cocoa grinder.

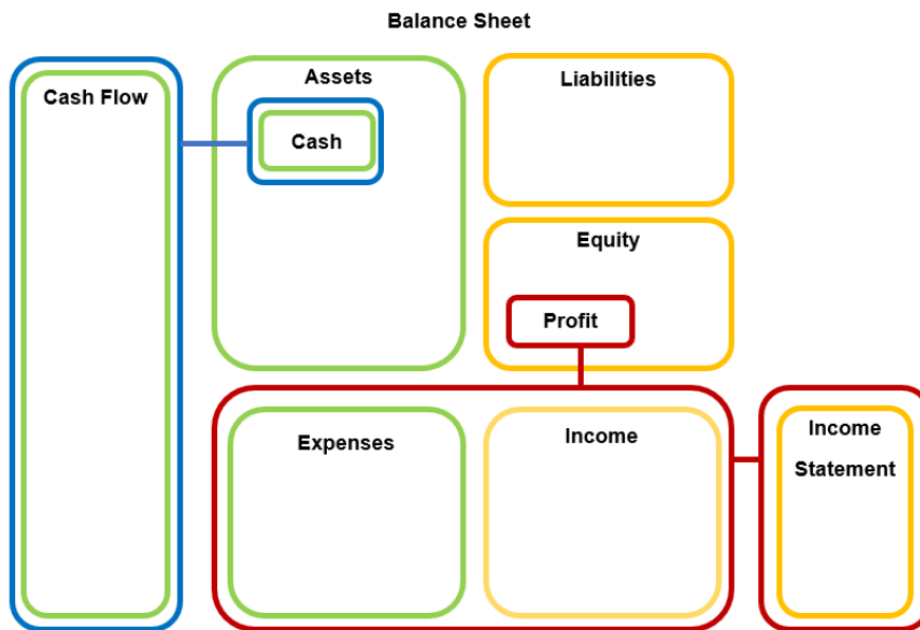


Figure 10 Balance Sheet, Income Statement, and Cash Flow are interconnected. Income Statement with Balance Sheet by Profit/Loss. Cash Flow and Balance Sheet by Cash.

		Business Simulator and Valuation Game by Olga Gould									
		Copyright © 2009 GLF VENTURE INC. All Rights Reserved.									
		2,019	2,020	2,021	2,022	2,023	2,024	2,025	2,026	2,027	2,028
Cash Flow (\$000 dollars)											
Cash Beginning of the Year		5,000	21,687	22,708	34,558	42,209	51,095	59,309	67,511	75,284	83,012
Sales	All costumers pay before the end of the year	32,400	17,660	20,048	20,048	20,048	20,048	20,048	20,048	20,048	20,048
Direct Cost	You pay your supplies with no delay	10,109	5,845	6,009	6,177	6,350	6,528	6,711	6,899	7,092	7,291
Advertising	You pay all the expense you need for the year	24	49	65							
Salaries	You pay your employees with no delay	1,920	2,066	2,124	2,184	2,245	2,308	2,372	2,439	2,507	2,577
Research and Development			3,000								
Equipment	You pay all the equipment with no delay	3,660	(1,443)	-	-	-	-	-	-	-	-
Taxes			7,122	-	4,035	2,566	2,998	2,763	2,936	2,721	2,705
Loans			-	-	-	-	-	-	-	-	-
Contributions											
Total Income		37,400	39,347	42,756	54,605	62,256	71,143	79,356	87,558	95,332	103,060
Total Expenses		15,713	16,639	8,198	12,396	11,161	11,834	11,846	12,274	12,320	12,572
Cash Flow at the end of the year		21,687	22,708	34,558	42,209	51,095	59,309	67,511	75,284	83,012	90,487

Figure 11 Cash Flow

		Business Simulator and Valuation Game by Olga Gould									
		Copyright © 2009 GLF VENTURE INC. All Rights Reserved.									
		2,019	2,020	2,021	2,022	2,023	2,024	2,025	2,026	2,027	2,028
Balance Sheet (\$000 dollars)											
As at											
Assets											
Cash		21,687	22,708	34,558	42,209	51,095	59,309	67,511	75,284	83,012	90,487
Equipment		3,660	1,709	1,389	1,069	748	428	616	616	616	616
Total Assets		25,347	24,417	35,946	43,277	51,844	59,737	68,127	75,901	83,628	91,104
Liabilities											
Bank Loan		-	-	-	-	-	-	-	-	-	-
Total Liabilities		0	0	0	0	0	0	0	0	0	0
Equity											
Share Capital		5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Contributed Surplus		-	-	-	-	-	-	-	-	-	-
Current Earnings (Net Income)		20,347	(930)	11,529	7,331	8,566	7,893	8,390	7,774	7,728	7,475
Retained Earnings Previous Year		-	20,347	19,417	30,946	38,277	46,844	54,737	63,127	70,901	78,628
Total Equity		25,347	24,417	35,946	43,277	51,844	59,737	68,127	75,901	83,628	91,104
Assets		25,347	24,417	35,946	43,277	51,844	59,737	68,127	75,901	83,628	91,104
Liabilities + Equity		25,347	24,417	35,946	43,277	51,844	59,737	68,127	75,901	83,628	91,104
Balance check (should be Zero)		-	-	(0.00)	-	0.00	0.00	-	-	-	-

Figure 12 Balance Sheet

Income Statement (\$000 dollars)

For the Year Ended	2,019	2,020	2,021	2,022	2,023	2,024	2,025	2,026	2,027	2,028
Revenue										
Sales	32,400	17,660	20,048	20,048	20,048	20,048	20,048	20,048	20,048	20,048
Total Revenue	32,400	17,660	20,048	20,048	20,048	20,048	20,048	20,048	20,048	20,048
Expenses										
Direct Cost	10,109	5,845	6,009	6,177	6,350	6,528	6,711	6,899	7,092	7,291
Depreciation		508	320	320	320	320	(188)	-	-	-
Advertising	24	49	65							
Salaries	1,920	2,066	2,124	2,184	2,245	2,308	2,372	2,439	2,507	2,577
Research and Development		3,000								
Total Expenses	12,053	11,469	8,518	8,681	8,915	9,156	8,895	9,337	9,599	9,868
Tax		7,122	-	4,035	2,566	2,998	2,763	2,936	2,721	2,705
Net Income (Loss)	20,347	(930)	11,529	7,331	8,566	7,893	8,390	7,774	7,728	7,475

Figure 13 Income Statement

Decision variables. Using-back-and-forth the 3D simulation and the Google Spreadsheet, students needed to make decisions on the following items.

- i. Sales price (in Canadian dollars) of the final product (processed cocoa). This is a decision made every year (run).
- ii. Advertisement expenses (in Canadian dollars). This is a decision made every year (run).
- iii. Purchase of equipment (number of each type of machine to purchase). When deciding about equipment purchase (production capacity), students should make sure they produce the least amount of waste that will affect the environment. This is a decision made every year (run).
- iv. Solving optimization challenges, such as deciding on the product mix in year 2, a transportation problem in year 3, and personnel scheduling in year 4.
- v. Approaching an ethical challenge about data privacy in year 5

We note that students do not need to decide on the amount of raw material needed as it was limited by the Production Capacity (bottleneck).

In order to decide about the sales price (i) and advertisement (ii), the students were informed about the needs, expectations, desires, and actions of the market. Then, they needed to work on the Empathy Map Canvas (see figure 14) to establish a type of a cocoa customer (Persona) who could be buying more if the price is low and if it is more influenced by the marketing campaigns. This leads the students to estimate the ideal product price and the amount to spend on marketing. To decide about the purchase of equipment (iii) the students are informed that the type of person who buys cocoa in the business simulation game will do so from a reputable company with the

least amount of waste. Then, the students understand that they should not produce more cocoa than they can sell, because the surplus would end up in the waste.



Figure 14 Updated Empathy Map Canvas by Dave Gray, XPLANE.

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Phase 2 (repeats every year)

At the end of each run (fiscal year), after the teams have made their decisions, the game calculates and allocates randomly the demand for each of the teams using random-variate generation like what is done on Discrete Simulation. Intuitively, the game distributes more demand to the groups with lower prices, higher expense on advertisement, and least amount of waste. On the contrary, the game reduces the market share for the next year to the teams that purchase more raw material than needed because this is considered waste that will damage the reputation of their environment-aware production.

In each of the years 2, 3 and 4 there is an optimization challenge and in year 5 there is an ethical challenge. See Figure 15. The optimization challenges consist of maximizing the profit in a product mix problem, minimize the costs of shipping goods in a transportation problem, and minimize the payroll costs in a staff scheduling problem. In the ethical challenge, the user needs to decide what source or material is more adequate to purchase based on sensitive information that the company should not be using in the decision process. The background of the ethical problem is explained in class.

At the end of each run the average of the prices and the average spent on advertisement of all the companies are available to all the class so that the students could see if they were above or below average compared to the other teams and determine what factors made them competitive or not.



Figure 15 In the Business simulation game, the user has assigned the optimal purchases of raw material from the providers that will harm the least, for example, data privacy, the environment, and labour conditions.

Phase 3.

The model calculates the value of each company using the Discounted Cash Flow (DCF) valuation method in each of the five runs; the company with the highest value wins the game [46]. Discounted cash flow (DCF) is a valuation method used to estimate the value of an investment based on its expected future cash flows. DCF analysis attempts to figure out the value of an investment today, based on projections of how much money it will generate in the future. The students receive the valuation of all the companies in each iteration, so they understand if they are above or below the competitors. This shows them if they have been taking good decisions on each opportunity. The DCF formula is as follows:

$$\text{Discounted Cash Flow} = \frac{CF^1}{(1 + dr)^1} + \frac{CF^2}{(1 + dr)^2} + \dots + \frac{CF^n}{(1 + dr)^n}$$

CF = Cash Flow
dr = discount rate

where CF^i is the cash flow of year i , and dr is the discount rate which is the interest rate charged to commercial banks and other financial institutions for short-term loans they take from the Federal Reserve Bank. Note that the superscript in the numerator is just an index for the year, whereas the superscript in the denominator is an exponent (power).

4.2 Dashboards, Business Intelligence, and Data Analytics in the 3D Business Simulation Game.

To achieve our goals it is important to highlight the principles that drive industries and the labor market in decision making and how important it is to newcomers to Canada. In 2021, Dresner Advisory Services, LLC's in the Wisdom of Crowds Business Intelligence Market Study [47] [48], found that dashboards, reporting, data integration, advanced visualization, are the topmost important technology initiatives strategic to BI. But the most important aspect to highlight in Columbus research is that enterprises with the largest BI budgets this year are investing more heavily into dashboards, reporting, and data integration. This could mean that professionals who understand dashboards, reporting, and data integration are more likely to be promoted or to succeed in their own companies as budgets are approved in advance for this purpose and the organization is committed to it. Therefore, teaching newcomers to Canada data-driven decision making can help them to advance in their careers.

A dashboard is a data visualization tool that tracks, analyzes, and displays KPIs, metrics, and critical data points. Dashboards empower both technical and non-technical users to understand and leverage business intelligence to make more informed decisions. Our game displays some metrics such as Key Performance Indicators, levels of production per machine, and the risk assessment, which was described in Section 3.2, after every decision has been made on the challenge. See Figures 16 and 17.

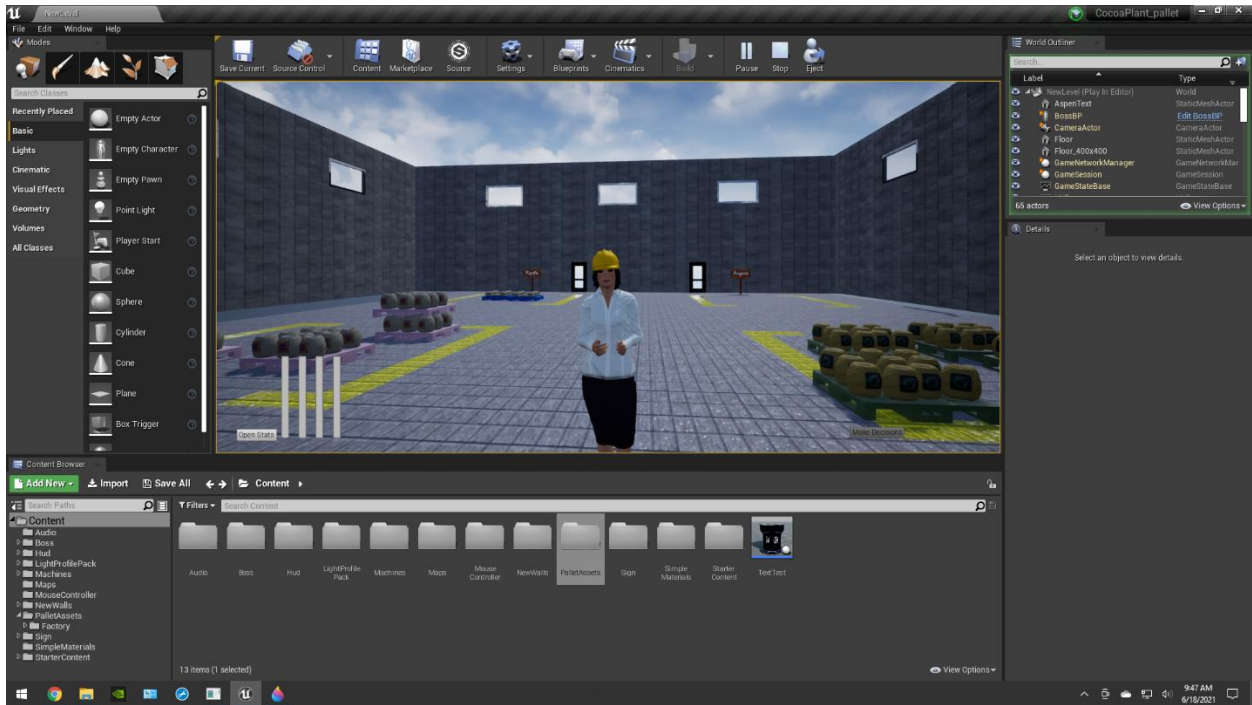


Figure 16 Ethical considerations are included in the business simulation game. For example, in this scenario the user needs to decide what source or material is more adequate to purchase based on ethical criteria. The background of the providers is explained in class.



Figure 17 Visualization of the data. It shows the user taking decisions after selecting the optimal amount of equipment that sets the capacity to supply demand.

One of our game goals is to familiarize students with Business Intelligence tools to improve decisions in organizations, in order to understand the broad of concepts under the BI umbrella. In class, students learn that vendors define Business Intelligence (BI) according to what their products can do for the business enterprise with a limited scope, as they mostly refer to data

analysis, querying, and reporting. On the contrary, in academia, BI is defined as a process, an organizational function, and a product, where there is room for strategic decisions based on knowledge, information from various sources, and experience of the user.

For example, IBM defines BI as a “category of applications and technologies for gathering, storing, analysing, reporting on and providing access to data to help enterprise users make better business decisions” [49][50]. The Gartner Group defines BI as a set of concepts and methods to improve business decision-making by using fact-based support systems [51]. Robert J. In his book *Effective Business Intelligence Systems 2001*, Thierauf expresses that “BI centres on computerised methods and processes to improve strategic, tactical and operational decisions using data, information, and knowledge from multiple sources as well as applying experience and assumptions to develop an accurate understanding of the dynamic surrounding decision making” [52].

When teaching data-driven decision-making in Entrepreneurship, it is important to emphasize that automated solutions can lead to decisions that can greatly affect organizations. Therefore, the clarity of the problems in business simulation games should allow students to doubt the results offered by automated systems and to support their decisions based on knowledge, experience, skills, and information from various key resources.

4.3 Optimization problem challenges

Our game presents several challenges to students regarding optimization problems for product mixing, transportation, and staff scheduling (see Figures 18 to 21). These problems can be solved by students in Excel using the ribbon Solver included on the Add-ins Statistical Analysis. Principles of Linear Programming and Simplex method were explained in class.

Product Mix Problem

In the Product Mix Problem, our game helps students visualize the purchase allocation of the raw material and understand decision variables, objective function, and constraints (see Figure 18). The Product Mix Problem is a basic example of how to set up a series of decision variables to optimize choices across what products to produce based on profit, ingredients used, and capacity (in this case grinding time and inventory). For this example, the company manufactures chocolate blocks using a common ingredient inventory of sugar, almonds, and nuts, and each bar requires a certain amount of grinding time. Both grinding time and ingredients are in limited supply and students must determine the most profitable mix of products to create.

Specifically, we are given the decision variables x_i which are the number of chocolate bars of the i types, Tahoe, Pacific, Savannah, and Aspen.

- x_1 *Number of Tahoe chocolate bars*
- x_2 *Number of Pacific chocolate bars*
- x_3 *Number of Savannah chocolate bars*
- x_4 *Number of Aspen chocolate bars*

Considering that the profit for each unit is set to \$450 for Tahoe, \$1,150 for Pacific, \$800 for Savannah and \$400 for Aspen, the objective function to be maximized is

$$F = \$450x_1 + \$1,150x_2 + \$800x_3 + \$400x_4$$

The amounts of ingredients needed for each brand is 50 pounds of sugar for Tahoe, 50 pounds of sugar for Pacific, 100 pounds of sugar for Savannah, and 50 pounds of sugar for Aspen; 500 pounds of almonds for Tahoe, 400 pounds of almonds for Pacific, 300 pounds of almonds for Savannah, and 10 pounds of almonds for Aspen; 500 pounds of nuts for Tahoe, 750 pounds of nuts for Pacific, 250 pounds of nuts for Savannah, and 500 pounds of nuts for Aspen.

Also, five hours of grinding time are needed per unit of Tahoe, 15 hours of grinding time are needed per unit of Pacific, 10 hours of grinding time are needed per unit of Savannah, and 5 hours of grinding time are needed per unit of Aspen. The constraints are the available ingredients that are available: 5,800 pounds of sugar, 29,200 pounds of almonds, and 6,050 pounds of nuts. The time allowed for grinding the products is 720 hours. All of these numbers are generated by our game. Finally, the complete optimization problem is expressed mathematically as follows:

Maximize profit

$$F = \$450x_1 + \$1,150x_2 + \$800x_3 + \$400x_4$$

Subject to

$$50x_1 + 50x_2 + 100x_3 + 50x_4 \leq 5,800 \text{ pounds of sugar}$$

$$500x_1 + 400x_2 + 300x_3 + 10x_4 \leq 29,200 \text{ pounds of almonds}$$

$$500x_1 + 750x_2 + 250x_3 + 500x_4 \leq 60,500 \text{ pounds of nuts}$$

$$5x_1 + 15x_2 + 10x_3 + 5x_4 \leq 720 \text{ hours of grinding time}$$

$$x_1, x_2, x_3, \text{ and } x_4 \geq 0$$

Product Mix Problem Example 1

This is a very basic example of how you can set up a series of decision variables to optimize choices across what products to produce based on product profit, ingredients used, and capacity (in this case grinding time and inventory). This model could easily be modified and scaled to take into account demand, many more products, etc. For this example, assume your company manufactures chocolate blocks using a common ingredients inventory of sugar, almonds, and nuts, and each bar requires a certain amount of grinding time. Both grinding time and ingredients are in limited supply and you must determine the most profitable mix of products to create.

Decision Variables

In this example you need to decide the optimal mix of bars to produce. As a result, we have set cells C18:F18 as our Decision Variables and have created the defined name, *Number_to_build*.

Variable Bounds

Since we won't be making a negative number of pallets, we've set each variable's lower bound to 0. These lower bounds appear in the Model Task Pane as *Number_to_build >= 0*.

Alternatively, we could set Assume Non-Negative to True on the Engine tab of the Task Pane.

Model Building Tip: Defined Names

In a large model, using defined names for a range of variables or constraint cells will create a more readable model for the User. To create a defined name, simply select the range of cells you want to name (for example C18:F18), click *Formulas* on the Excel Ribbon, and then select *Name Manager*.

Objective Function

Our objective in this model is to maximize profit. As a result, we have chosen to maximize our Objective located in cell G19 and named this cell *Total_profit*.

Constraints

The example model contains four constraints which limit the number of ingredients or grinding time used per product to the amount available. In the Model tab of the Task Pane, these constraints appear as: *Number_Used <= Number_Available*.

		Chocolate Block Brands						
		Tahoe	Pacific	Javanna	Aspen			Total Profit
Blocks								
Profit		\$450	\$1,150	\$800	\$400			\$0
		Resources Required per Block Type				Used	Available	
Sugar		50	50	100	50	0	5,800	pounds
Grinding time		5	15	10	5	0	720	max hours
Almonds		500	400	300	10	0	29,200	pounds
Nuts		500	750	250	500	0	60,500	pounds

Model Notes

Although this is a good basic example of a product mix problem, bear in mind the limitations of this model. For example, market demand and price elasticity are not included in the model – we assume that it does not matter how many blocks of chocolate of each type we build, we will always be able to sell them. Nor are there any pre-specified minimum or maximum number of products that are required to be manufactured. The effect of introducing these restrictions can be studied by examining a Sensitivity Report, which you can create after the status bar shows "Solver found a solution." by clicking *Reports* on the RSP ribbon and then selecting *Optimization* and then *Sensitivity*.

Figure 18 Product Mix Optimization Problem. The table showing the Objective Function, and constraints is called *Tableau*.



Figure 19 Students allocate how much of raw material is needed to solve the Production Mix optimization problem.

In the following optimization problems, students are asked to solve other Optimization problems, such as transportation and personnel scheduling.

Transportation Problem

In the optimization problem of transportation, students need to minimize the costs of shipping goods from three production plants in South Carolina, Tennessee, and Arizona to five warehouses in San Francisco, Denver, Chicago, Dallas, and New York, while not exceeding the supply available from each plant and meeting the demand from each metropolitan area. Goods can be shipped from any plant to any warehouse, but it obviously costs more to ship goods over longer distances.

The problem is to determine the amounts to ship from each plant to each warehouse at a minimum shipping cost in order to meet regional demand, while not exceeding the plant supplies.

We define variables x_{ij} as the amount to ship, and y_{ij} the cost to ship, respectively, from warehouse i to plant j . Then, the objective function is

$$F = \sum_{i=1}^3 \sum_{j=1}^5 x_{ij}y_{ij},$$

which needs be minimized subject to the constraints that the total shipped must be less than or equal to the supply requested by each plant. Formally these constraints are as follows:

$$\sum_{i=1}^3 x_{i1}y_{i1} \leq \$540$$

$$\sum_{i=1}^3 x_{i2}y_{i2} \leq \$230$$

$$\sum_{i=1}^3 x_{i3}y_{i3} \leq \$820$$

$$\sum_{i=1}^3 x_{i4}y_{i4} \leq \$640$$

$$\sum_{i=1}^3 x_{i5}y_{i5} \leq \$880$$

Also, totals goods shipped to warehouses must be greater than or equal to demand (tons) at warehouses.

$$\sum_{i=1}^3 x_{i1} \geq 180$$

$$\sum_{i=1}^3 x_{i2} \geq 80$$

$$\sum_{i=1}^3 x_{i3} \geq 200$$

$$\sum_{i=1}^3 x_{i4} \geq 160$$

$$\sum_{i=1}^3 x_{i5} \geq 220$$

x_{ij} amount to ship must be greater than or equal to 0. The numbers on the right of the above inequalities are generated by our game. See Figure 20 for a tableau of this problem.

Example 2: Transportation Problem.

Minimize the costs of shipping goods from production plants to warehouses near metropolitan demand centers, while not exceeding the supply available from each plant and meeting the demand from each metropolitan area.

		<i>Number to ship from plant x to warehouse y (at intersection):</i>				
<i>Plants:</i>	<i>Total</i>	<i>San Fran</i>	<i>Denver</i>	<i>Chicago</i>	<i>Dallas</i>	<i>New York</i>
S. Carolina	0					
Tennessee	0					
Arizona	0					
Totals:		0	0	0	0	0
<i>Demands by Warehouse →</i>		180	80	200	160	220
		<i>Shipping costs from plant x to warehouse y (at intersection):</i>				
<i>Plants:</i>	<i>Supply</i>					
S. Carolina	310	10	8	6	5	4
Tennessee	260	6	5	4	3	6
Arizona	280	3	4	5	5	9
<i>Shipping:</i>	\$0	\$0	\$0	\$0	\$0	\$0

The problem presented in this model involves the shipment of goods from three plants to five regional warehouses. Goods can be shipped from any plant to any warehouse, but it obviously costs more to ship goods over long distances than over short distances. The problem is to determine the amounts to ship from each plant to each warehouse at minimum shipping cost in order to meet the regional demand, while not exceeding the plant supplies.

Figure 20 Optimization Transportation problem tableau.

Personnel Scheduling

The Personnel Scheduling Optimization problem is about finding the schedule that meets demand for employees working five consecutive days with two days off. In our game, we have seven kinds of schedules, which we denote by A, B, C, D, E, F, G as shown in Figure 21. For example, schedule A means the employee will work every day of the week but Sunday and Monday, which are their days off. We use variables x_i to represent the number of employees on each of the seven schedules. Also, we use indicator variables y_{ij} to indicate whether day j of the week is an off day

in schedule i . y_{ij} is 1 when the schedule i is a working day of the week or 0 when it is a day off. Now the objective function is to minimize the payroll costs

$$\sum_{i=1}^7 x_i \cdot \$40$$

Subject to

$$\sum_{i=1}^7 x_i y_{i1} \geq 22$$

$$\sum_{i=1}^7 x_i y_{i2} \geq 17$$

$$\sum_{i=1}^7 x_i y_{i3} \geq 13$$

$$\sum_{i=1}^7 x_i y_{i4} \geq 14$$

$$\sum_{i=1}^7 x_i y_{i5} \geq 15$$

$$\sum_{i=1}^7 x_i y_{i6} \geq 18$$

$$\sum_{i=1}^7 x_i y_{i7} \geq 24$$

The number of employees working each day must be greater than or equal to the demand in a plant. The numbers on the right of the above inequalities are generated by the game. Also, we add all of the $x_{ij} \geq 0$ constraints, which means that the number of employees must be greater than or equal to 0.

Finally, the number of employees must be an integer, so the Linear Programming solutions will be rounded by the students. In this game, we do not deal with more precise solutions provided by algorithms in Integer Programming. See Figure 21 for a tableau of this problem.

For employees working five consecutive days with two days off, find the schedule that meets demand from attendance levels while minimizing payroll costs.

Sch.	Days off	Employees	Sun	Mon	Tue	Wed	Thu	Fri	Sat
A	Sunday, Monday		0	0	1	1	1	1	1
B	Monday, Tuesday		1	0	0	1	1	1	1
C	Tuesday, Wed.		1	1	0	0	1	1	1
D	Wed., Thursday		1	1	1	0	0	1	1
E	Thursday, Friday		1	1	1	1	0	0	1
F	Friday, Saturday		1	1	1	1	1	0	0
G	Saturday, Sunday		0	1	1	1	1	1	0
Schedule Totals:		0	0	0	0	0	0	0	0
Total Demand:			22	17	13	14	15	18	24
Pay/Employee/Day:		\$40							
Payroll/Week:		\$0							

The goal for this model is to schedule employees so that you have sufficient staff at the lowest cost. In this example, all employees are paid at the same rate, so by minimizing the number of employees working each day, you also minimize costs. Each employee works five consecutive days, followed by two days off.

Figure 21 Personnel Scheduling. Optimization problems Example 3

4.4 Game Implementation Details

The engine game used for this Business Simulation Game is Unreal Engine 4 (UE4). To give the impression of a third-person game, the main character and the user who is walking around representing the user who makes the decisions were created in Adobe Fuse. The character is imported into Mixamo. Mixamo, which uses machine learning methods to automate the steps of the character animation process, including 3D modeling, rigging, and 3D animation. Then, the setup animation or blueprint is created in UE4 to connect the parts.

The assets for the game are three distinct types of machines to process cocoa and pallets. They are modeled and UV⁶ mapped in Blender⁷. UV mapping involves taking a 3D mesh and unwrapping it into a 2D one. This process is done so that normal maps and textures can be created. The normal maps (textures) are made in Substance Painter. Normal maps are exported and imported into Unreal Engine, then materials are created, and the normal maps are connected to the nodes⁸ (Unreal Engine 4 uses a node-based visual scripting).

⁶ UV mapping is the 3D modeling process of projecting a 2D image into a 3D model's surface for texture mapping.

⁷ Blender is the 3D modeling process of projecting a 2D image into a 3D model's surface for texture mapping.

⁸ A node-based interface to mostly create gameplay elements. As with many common scripting languages, it is used to define object-oriented (OO) classes or objects in the engine. Under the hood these are just C++ functions.

If the assets are movable within the business simulation game, then they must be assigned to a *blueprint*. A blueprint is an UE4 system that uses visual nodes for scripting (see Figure 22). Unreal Engine also makes possible the creation of HUDs, or Heads Up Display, which allows questions to be shown to the user so they may make decisions. HUDs are programmed in a similar fashion using the blueprint system.

Once the Business Simulation Game has finished programming, the process of packaging is the next step. Packaging is when the game engine compresses all of the information into a set of files which includes an executable that can be saved into a folder, then it can be published online or embedded on a website.

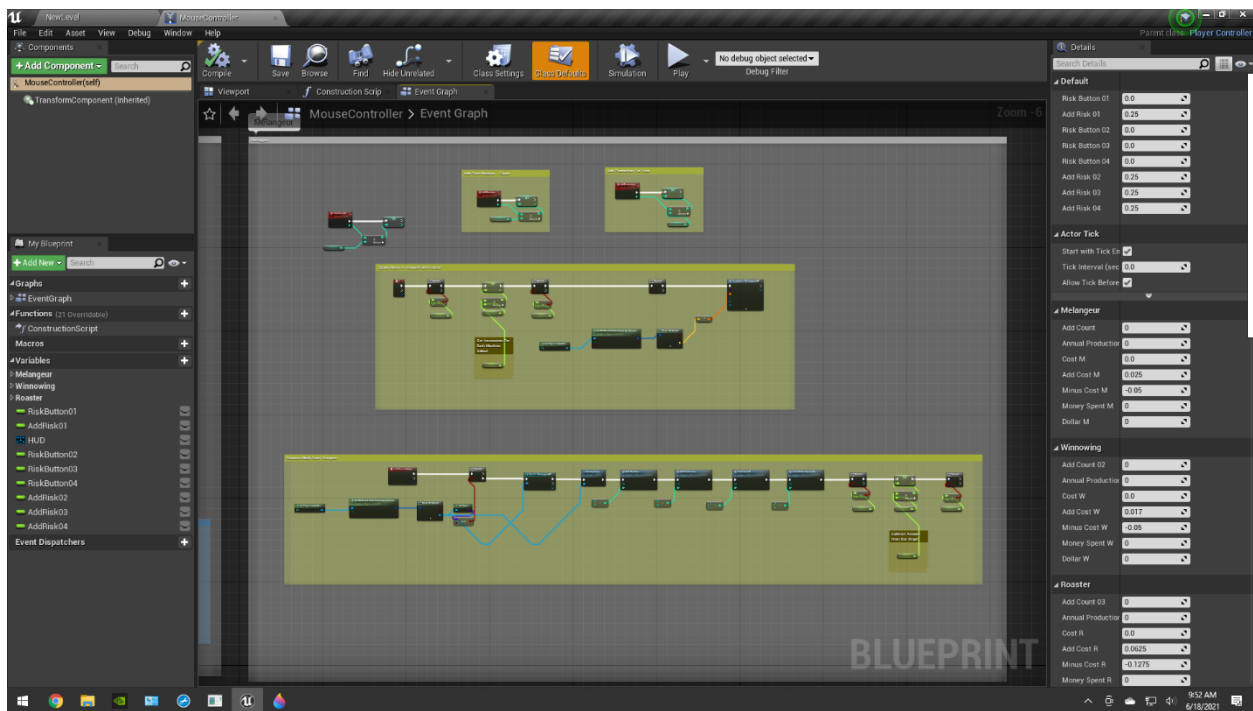


Figure 22 Blueprints with nodes

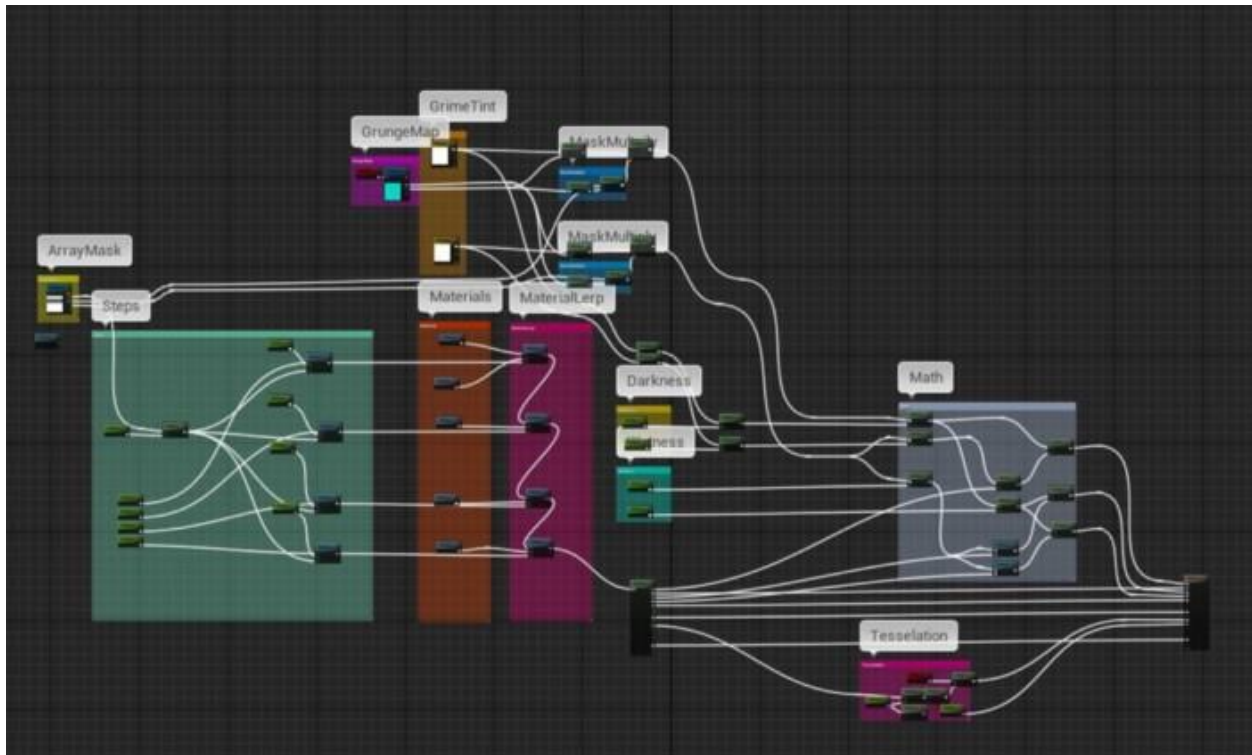


Figure 23 Blueprints with nodes

5. Assessment

After designing, developing, and testing the business simulation game, we conducted a comprehensive assessment to see if the decisions made by the students during the game were correct. We also evaluated if the challenges were easier to understand, if it was clearer than using text only, and if the decision that was made was effective as a team. Also, the survey questions of this research aimed to answer whether the teaching of this entrepreneurship course with our game improved the understanding of Decision Support Systems for students. Additionally, we also reviewed the results from the simulation game to evaluate what percentage of the challenges were answered correctly. The questions were asked on the last day of the course to evaluate if students found the game valuable to their learning process and to find out if they thought their decision-making process had improved.

Since the students had a limited English vocabulary, the questions had to be explained and broken down in class for them to better understand what was asked. The questions were designed to be of a general nature rather than specific in order to avoid questions that might be misinterpreted. The participants of this research were adults between 23 and 64 years old. All had the equivalent

of a high school education and 60% had some form of college degree. These students were immigrants or refugees who had been in the country for less than five years.

5.1 Game results and feedback

To reiterate, using back-and-forth our 3D simulation game and the Google Spreadsheet, students needed to make decisions every year (run) on the following decision variables:

- i. Sales price (in Canadian dollars) of the final product (processed cocoa). This is a decision made every year (run).
- ii. Advertisement expenses (in Canadian dollars). This is a decision made every year (run).
- iii. Purchase of equipment (number of each type of machines to purchase). When deciding about equipment purchase (production capacity), students should make sure they produce the least amount of waste that will affect the environment. This is a decision made every year (run).
- iv. Solving optimization challenges, such as deciding on the product mix in year 2, a transportation problem in year 3, and personnel scheduling in year 4.
- v. Approaching an ethical challenge about data privacy in year 5

Students know they made the right decisions because at the end of each iteration they are given feedback on their performance. Average prices and average advertising costs for all companies are available to the entire class, so students can see if they are above or below the average and whether that makes them competitive or not. The students also receive a valuation of all of the companies in each iteration, so that they understand if they are above or below their competitors.

In each of the following figures, we describe the results from a **survey** we conducted with students. We also evaluated if challenges were easier to understand, both as a team and individually, when students used our 3D business simulation game compared to a situation with only written descriptions of the problems. The survey questions and answers were as follows:

Question 1: Were you able to understand most of the wording of the challenges just by reading the text before playing the 3D Business Simulation game (all five years)?

This question was created to compare the learning outcomes of two separate ways of making decisions based on reading the challenge text or playing the 3D business simulation game. The students answered 1 to 5, where 1 is does not understand and 5 understands everything. Based on the results, we conclude that only 12 out of 30 (40%) students had a high understanding of most of the challenges and decisions they had to make during the five years of the game just before the 3D simulation game was presented.

30 responses

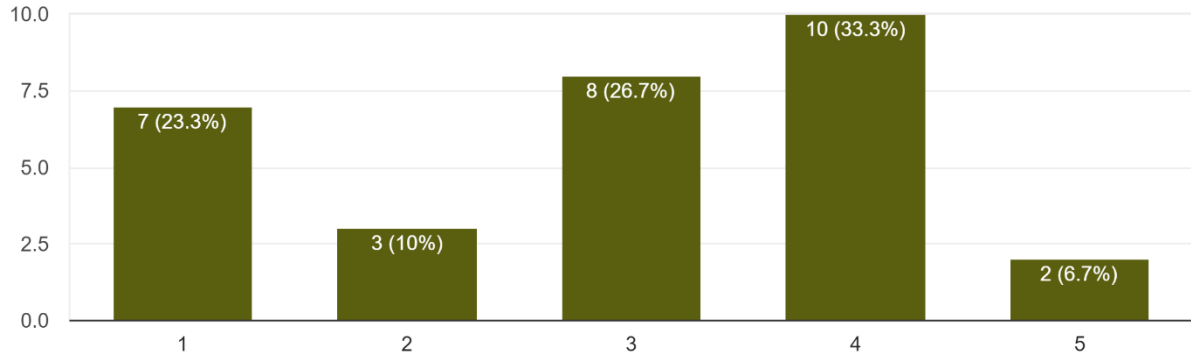


Figure 24 Question 1: Only 40% of the students had a high understanding of most of the challenges and decisions they had to make during the five years of the game before using the 3D simulation game.

Question 2: Were you able to understand most of the challenges after practicing what you learned in the 3D Simulation game (all five years)?

In the answers received to Question 2, we can see that 98% of the students understood better what they had to solve once the 3D business simulation game was presented. When compared to the results of the previous question, this is a good indicator that the game was helpful.

Based on data collected from the game (not the survey) we observed that almost 60% of the students took a long time (some groups up to 20 minutes) to understand what to do in the game

and they seemed to be confused with following instructions when the 3D animation was not part of the process. This may indicate that they were relying on animations for future decision making.

30 responses

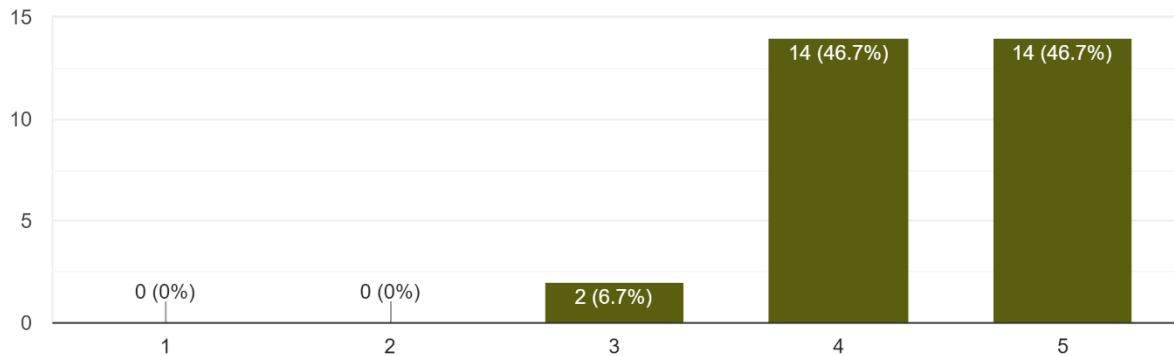


Figure 25 Question 2: 93.4% of the students have better understanding of what they had to solve once the 3D business simulation game was presented.

Question 3: Did the difficulty level increase appropriately as you progressed through the 3D business simulation game?

30 responses

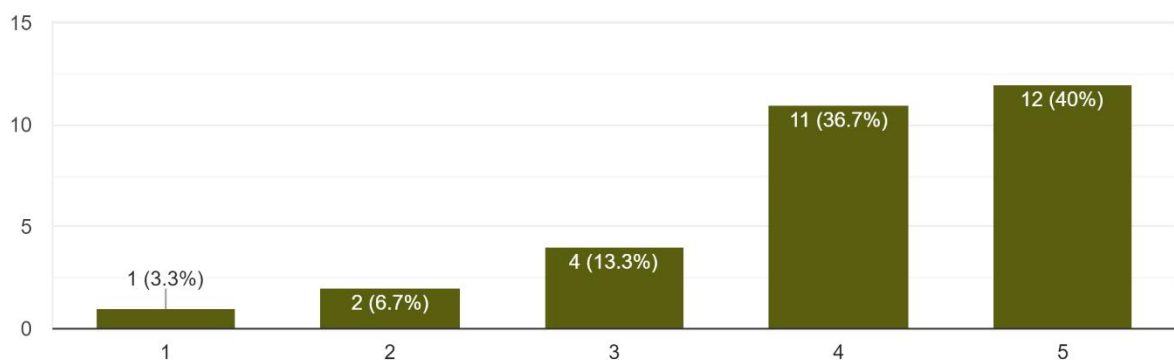


Figure 26 Question 4: Almost 76.7% of the students think that the difficulty level of the game increased appropriately

Based on Question 3, we concluded that nearly 76.7% of students think that the difficulty level of the 3D business simulation game increased appropriately as the student progressed through the game. This could mean that they found a logical sequence in the game and that the challenges were well designed to cover the course material.

Question 4: How relevant was the 3D simulation game to you (helped you improve your knowledge and skills)?

30 responses

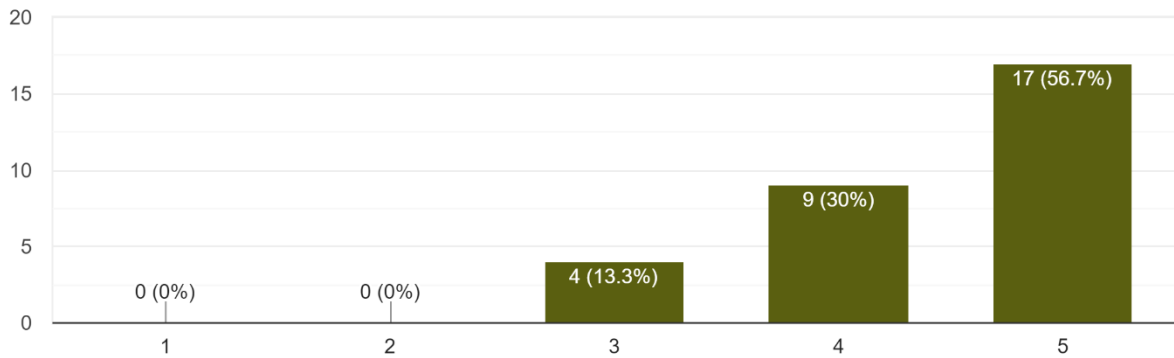


Figure 27 Question 4: All 30 students found the game important to improve the skills taught in class.

Based on the answers to Question 4, we can see that all the 30 students found the game important to help improve the knowledge and skills taught in class.

Question 5: How would you rate the sequence in which each of the challenges were introduced in the learning process? 1 not good to 5 very good.

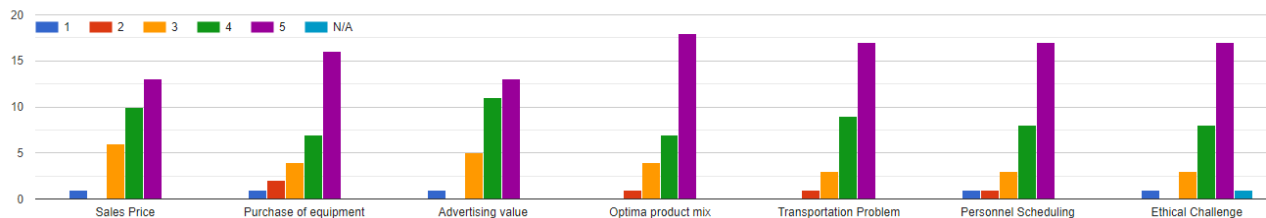


Figure 28 Question 5: Defining a sales price was not an easy task as the students had to observe the competitor's price and the impact of the prices in past years.

Although Question 5 referred to the logic of the sequence of the challenges, it can be deduced that some challenges were more complex than others.

Defining a sale price and how much was spent on advertising each year was not an easy task since the students had to carry out a market analysis with the mind map and observe the behavior of

other companies. This observation exercise was possible since at the end of each year the students received information on the average prices and advertising, and it was not decided by using the 3D simulation game.

As can be seen from the results, buying the equipment needed to supply the demand was an easier process as the 3D business simulation game helped them visualize the production level and bottlenecks.

Regarding the optimization problems, the students found the product mix, transportation and personnel scheduling challenges easier to solve than finding the ideal prices and advertising costs. Judging by the results of the game data, the easiest challenge to understand and quickly solve was the product mix challenge.

Finally, this survey question shows that the ethical challenge was also easy to solve. The game data reinforces this conclusion as it showed that this challenge needed less time than the rest of the challenges.

Question 6: Do you think you were you able to solve most of the challenges successfully as a team?

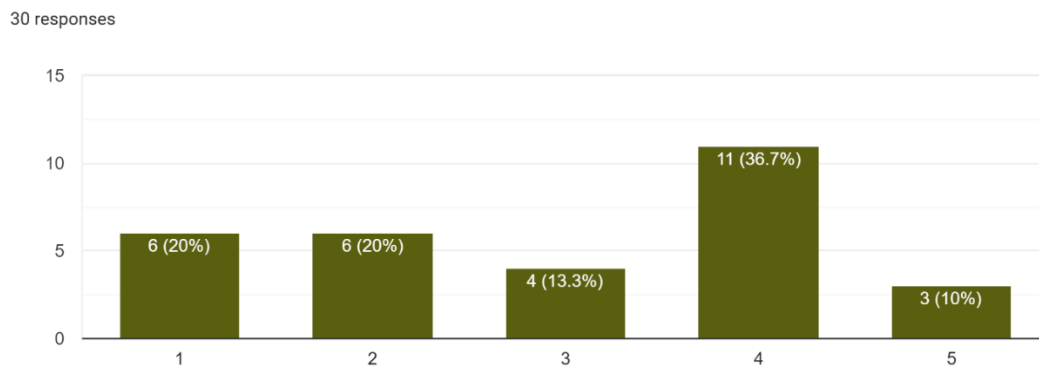


Figure 29 Question 6: None of the teams were able to make unanimous decisions in all seven levels in all the five years the students were able to play.

Question 6 asked if the students made a unanimous decision since we observed in class that this was one of their biggest challenges. The answers to this question show that 90% of the students thought they were successful working as a team. However, according to what was observed in class, none of the teams was able to make unanimous decisions at all levels in all five years of play. This was problematic as having different opinions made the students take too long to make up their minds, and the game had to be stopped several times.

Decision variables such as price, advertising costs, and number of machines needed were decided by majority vote in the groups. As 12 of 30 students stated that they needed more time to work on optimization problems, the due date to make decision was moved to the next class (a week).

Question 7: Do you think you were able to solve most of the challenges successfully individually?

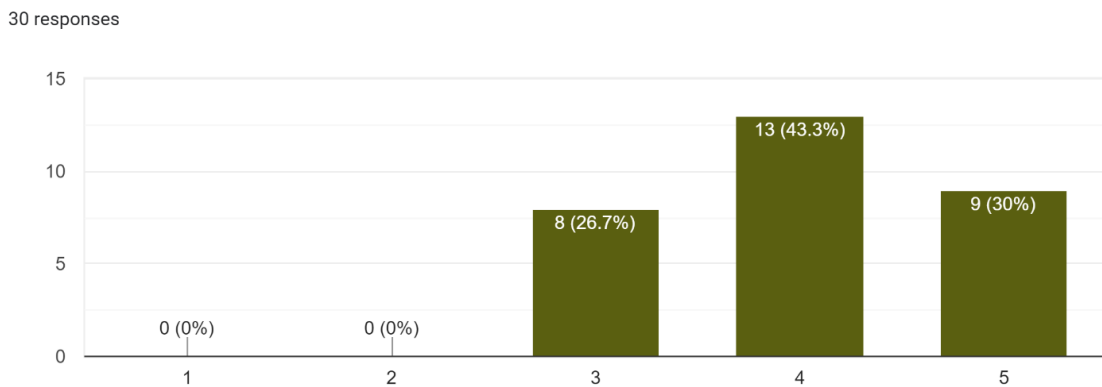


Figure 30 Question 7: All the students answered this question positively.

Based on the answers to Question 7, we can conclude that all the students responded positively to this question; however, based on data collected from game, we found that about 75% of the students were able to make decisions correctly individually, not all of them. Still, this may mean that including our 3D business simulation game in teaching of entrepreneurship can help in enabling students make their business decisions.

Question 8: How would you rate the overall appearance of the simulation game?

30 responses

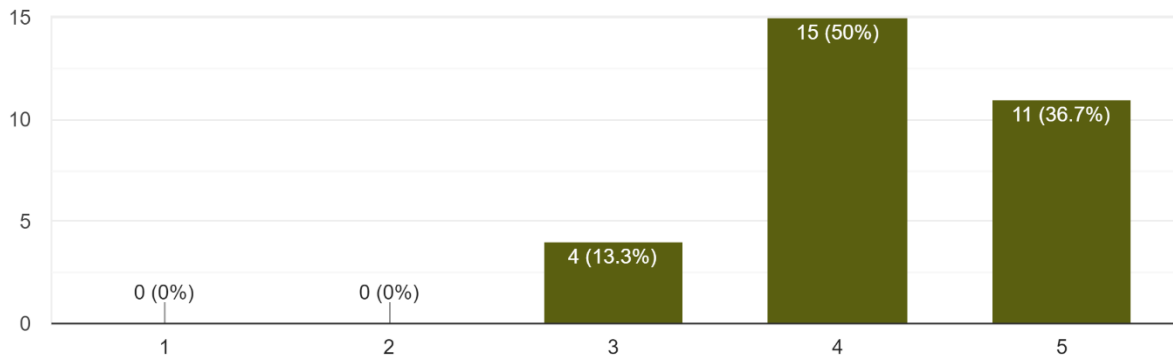


Figure 31 Question 8: Overall, the students found the game useful.

Based on the answers to Question 8, it can be concluded that the students enjoyed the graphics and colours of the game.

Question 9: As a learning platform, what was the best and most frustrating aspect of the game?

The most common responses to open Question 9 from the students follow:

- Overall, students found it positive that they could learn to make better business decisions year after year by playing a 3D business simulation game. They mentioned that it was fun to play a game with other adults and that it helped them feel more comfortable expressing their ideas in class.
- Several students pointed out that the character walked too slow.
- According to 12 students it took them considerable time to adapt to the keyboard commands so as not to confuse the keys that add machinery with those that move the character. This is because many keys on the keyboard have been assigned to perform different tasks: The A key was used to drop (buy) the roaster, the S key to drop (buy) the grinder, and the D key to drop (buy) the winnow; in addition, the left mouse click was assigned to click and delete the team in case of errors. To move the character the letters I (forward), J (left), L (right), M (back) were assigned, they were difficult to memorize and use while playing. This was confusing throughout the game.
- Students suggested including a joystick/controller to move the character.

6. Conclusions and Future Work

The reason a customizable 3D business simulation game was chosen was because of the growing importance of teaching entrepreneurship as a key factor for the economic growth and social progress of society [53]. The potential of a 3D simulation game to create a more fun, exciting, interesting, and immersive environment than what traditional business games can offer will have a significant impact in both the public and private sectors in the coming years. This research has shown that new immigrants to Canada can learn new skills, concepts, theories, and complex business language while playing a 3D simulation game. Students can gain better reasoning when there is room for increased business creativity.

An interesting aspect we observed is that when the 3D animation was not part of the course material or the business simulation game, students seemed to be confused with following instructions, whereas with the 3D animation the instructions were easier to understand. This shows that the students depended on the game animations for future decision-making. This could indicate that the students found the game useful. It could also mean that it can take their attention away from other aspects of the course, although there was a clear increase in student participation in the rest of the course activities.

In the future we plan to consider more closely the interaction of users with the game and make improvements based on principles of Human-Computer Interaction (HCI). In particular, it is important to adapt the game in the future so that students can work in a more natural and understandable way as the game is quite rudimentary now. For example, keyboard keys were used for character movements and to make machinery appear and disappear, which interrupts the learning process of what is important to learn with the game.

Another direction for improvement is the integration of IoTs that communicate with the game with voice activated commands. For example, the team can make decisions by ordering the machinery with their voice while discussing with their teammates. Virtual reality could also help to improve the movement of the user with hand controllers.

A next step in this research could include the adaptation of automatization of multi-user video games based on a model by Hunicke, LeBlanc and Zubek [54] that includes the mechanics of the game (clear rules, reactions to actions of the user, and data structures communication), game dynamics (runtime behavior of mechanics, for example changes in scenery) and therefore game provoked aesthetic (emotional responses evoked in the player).

Effective teamwork was one of the difficulties encountered in this research since no group could make unanimous decisions. We believe that before working on this simulation game, the dynamics of teamwork should be improved and better group decision-making should be promoted. For this research, an individual strengths test (SDI) was carried out, but the length of course time was limited and the number of students who participated in the test was not ideal. Also, teaching

negotiation strategies and persuasion techniques will surely help students perform better as part of a team in this game and help them in their future professional performance.

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List of Appendices

- A. Game Design screenshots
- B. Certification of Approval Human Research Ethics

Appendix A. Game Design screenshots.

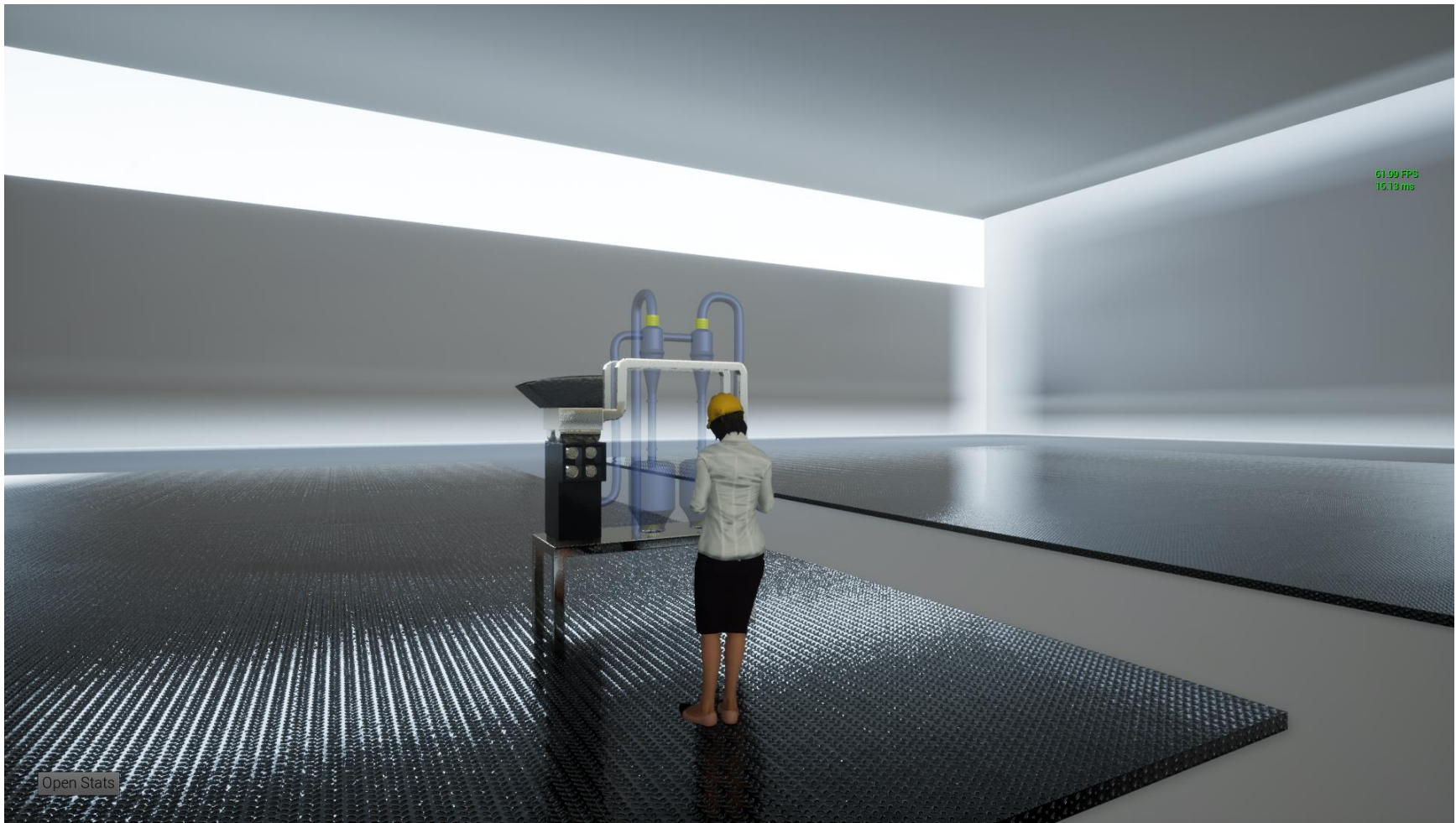


Figure 32 shows the character in front of a cocoa winnower, Winnowing is the process of removing the outer shell from the cocoa beans.



Figure 33 shows the character in front of a cocoa roaster (toaster).



Figure 34 shows the character in front of a cocoa grinder.

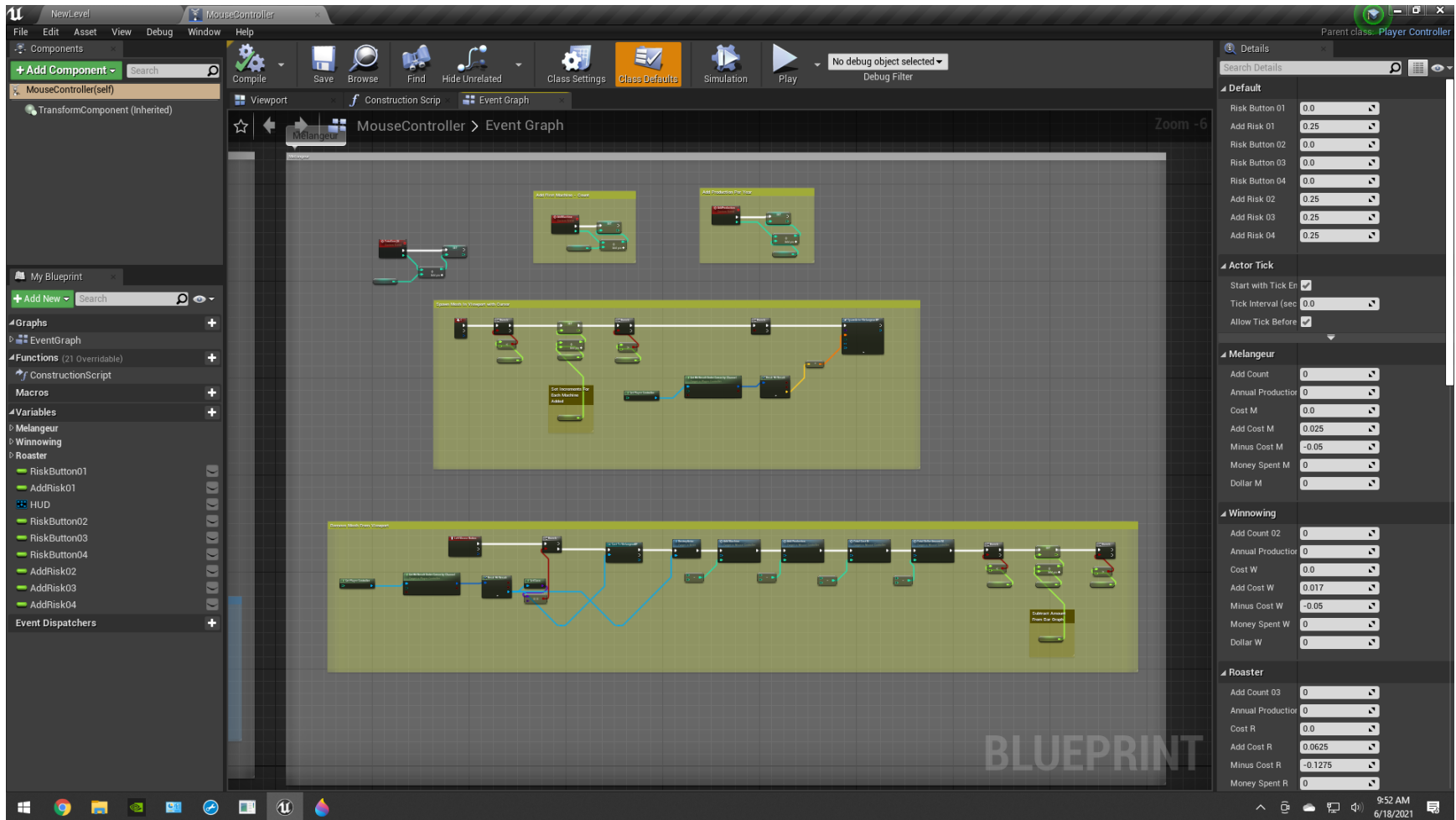


Figure 35 Each machine is programmed to be added or subtracted based on keyboard and mouse inputs assigned to the coding. There is a blueprint for each type of machine.

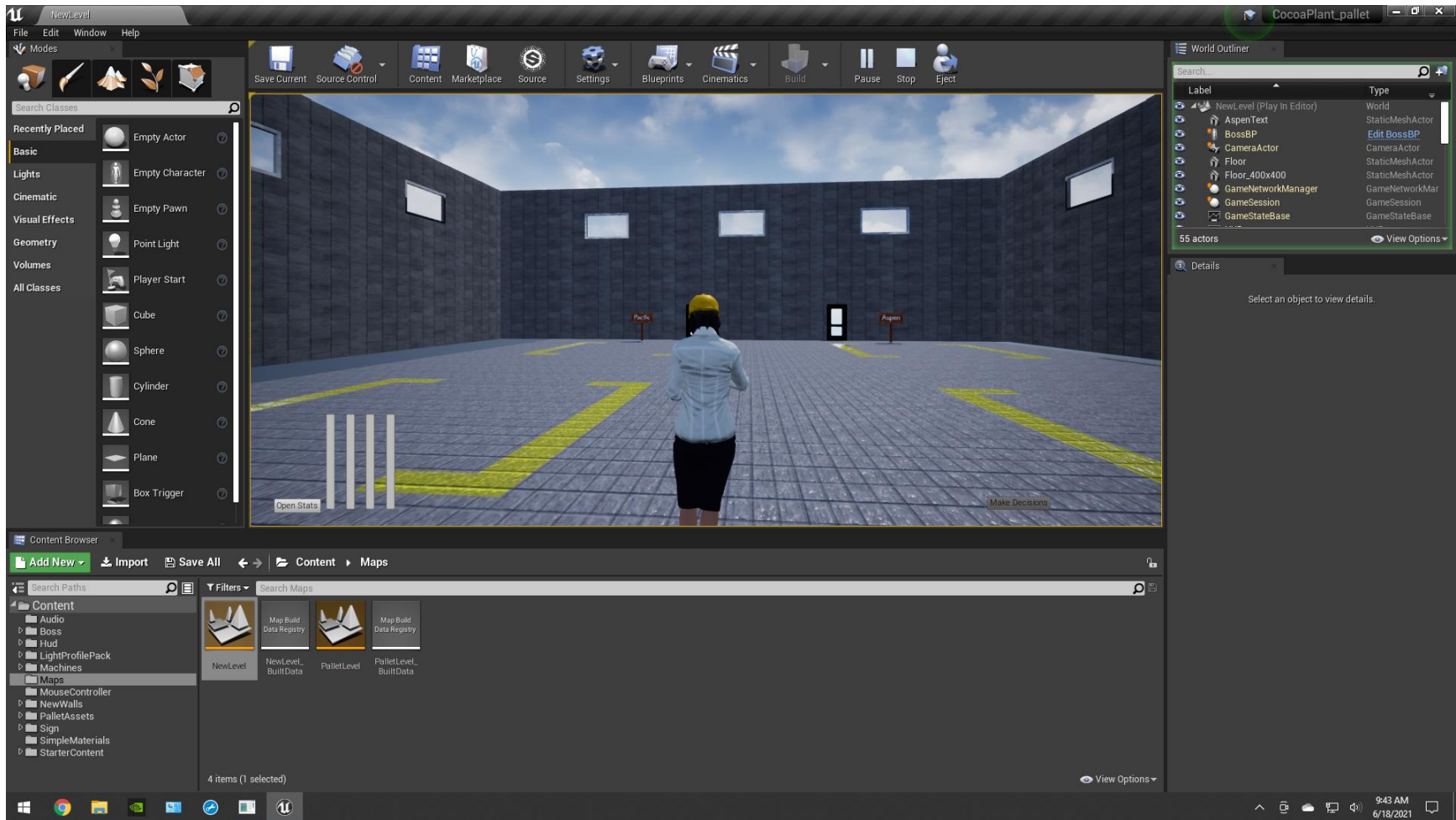


Figure 36 Ethical considerations are included in the game. On this section the user needs to decide what source or material is more adequate to purchase. The background of the providers is explained in class.

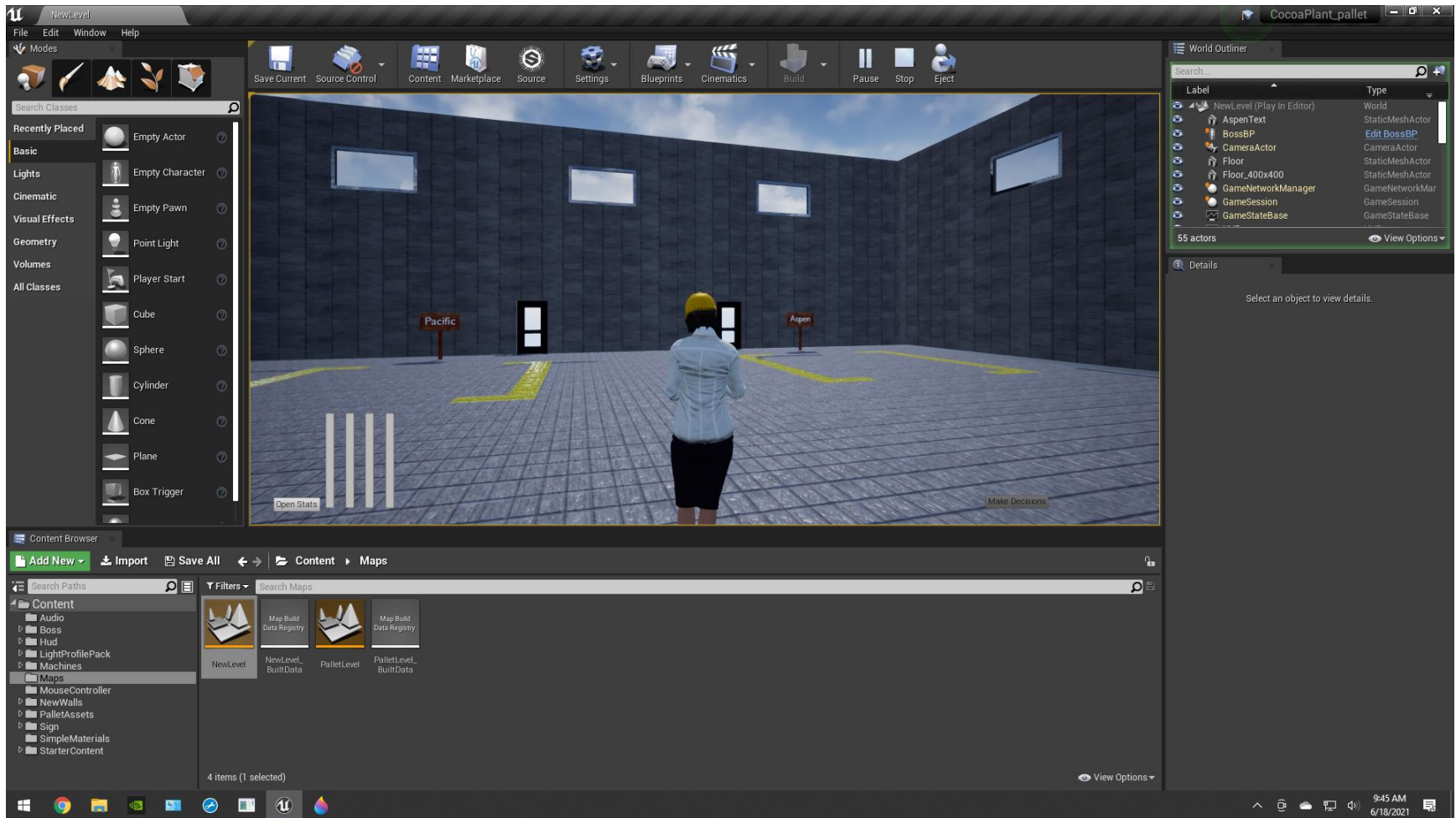


Figure 37 The user needs to add the number of pallets with bags of cocoa beans from different providers

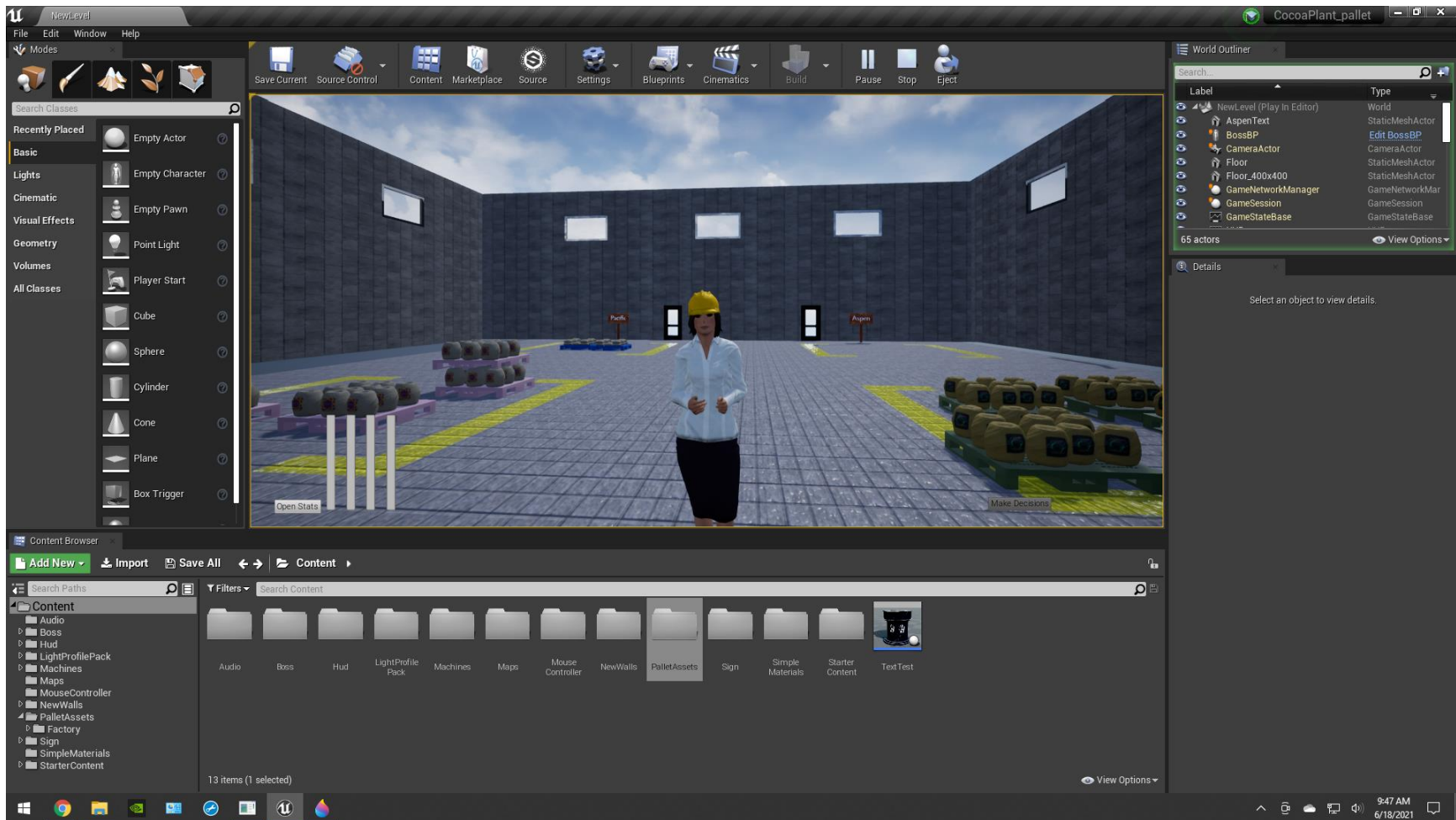


Figure 38 On this figure the user has assigned the optimal number of purchases from the providers that will harm the least, for example environment, labour conditions etc.



Figure 39 The United Nations Sustainable Development Goals (SDGs) are targets for global development set to be achieved by 2030. The students learn these concepts in class. In the game the students are challenged to take decisions based on reaching these goals.



Figure 40 Unreal Engine allows one to create the HUDS, or Heads Up Display, which allows the questions to be shown to the user so they may make decisions which are provided.



Figure 41 Sample of ethical challenge. .



Figure 42 Based on the demand from the customer and the production capacity of the machines the user finds the optimal amount of equipment

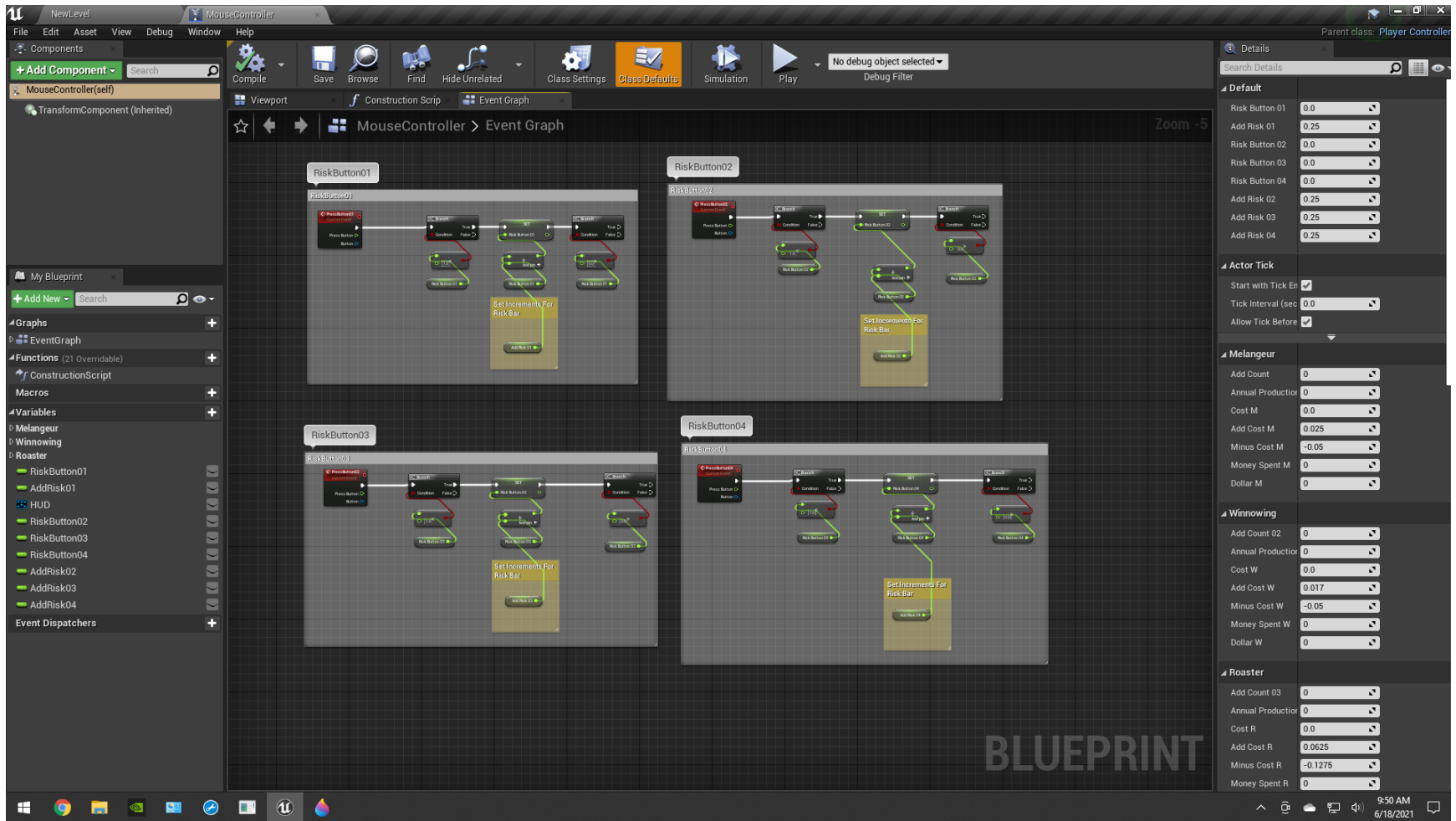


Figure 43 shows the nodes with four challenges and the risks the user takes every time a decision is made.

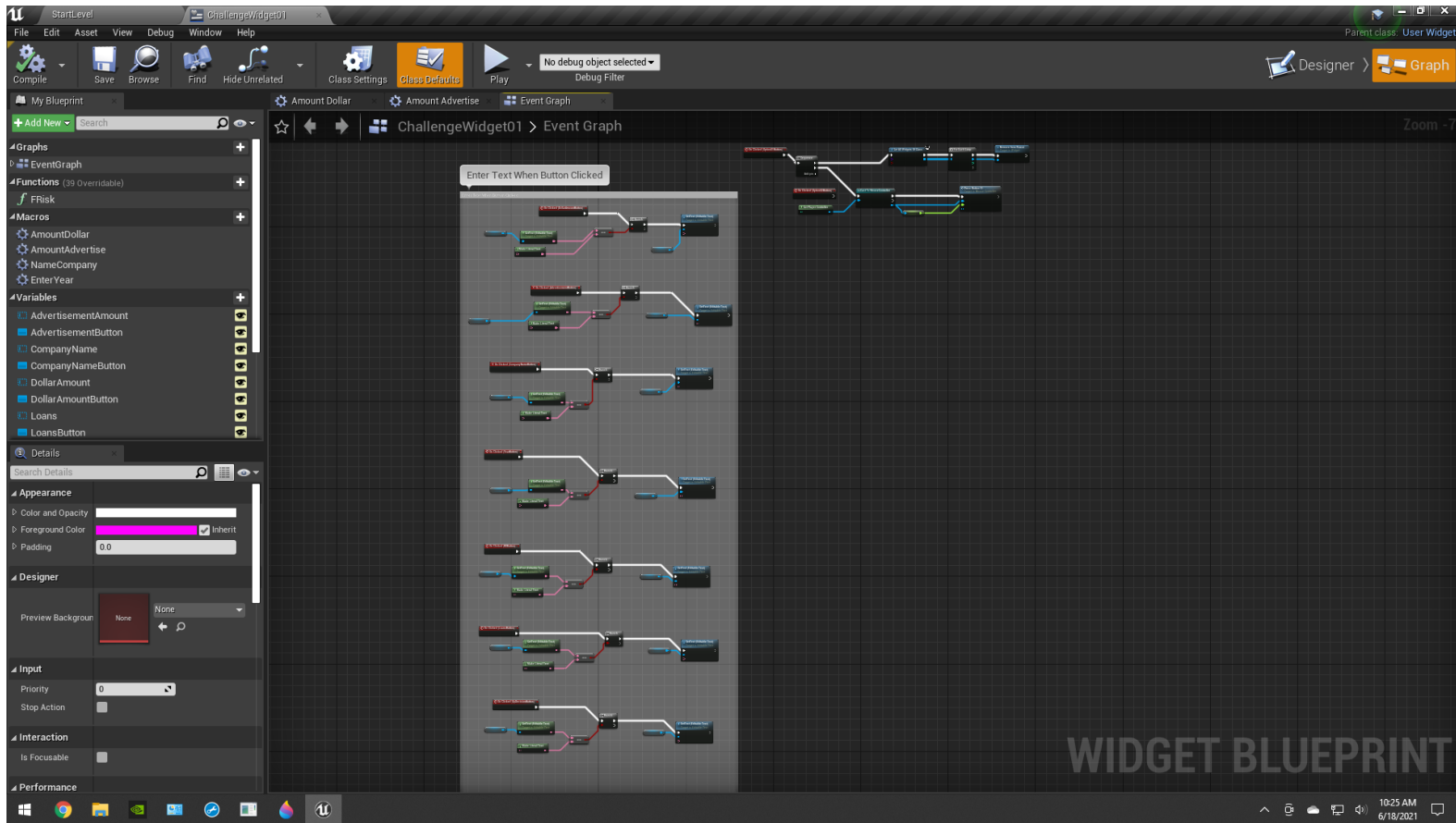


Figure 44 Unreal Engine allows one to create the HUDs, or Heads Up Display, which allows the questions to be shown to the user so they may make decisions which are provided.

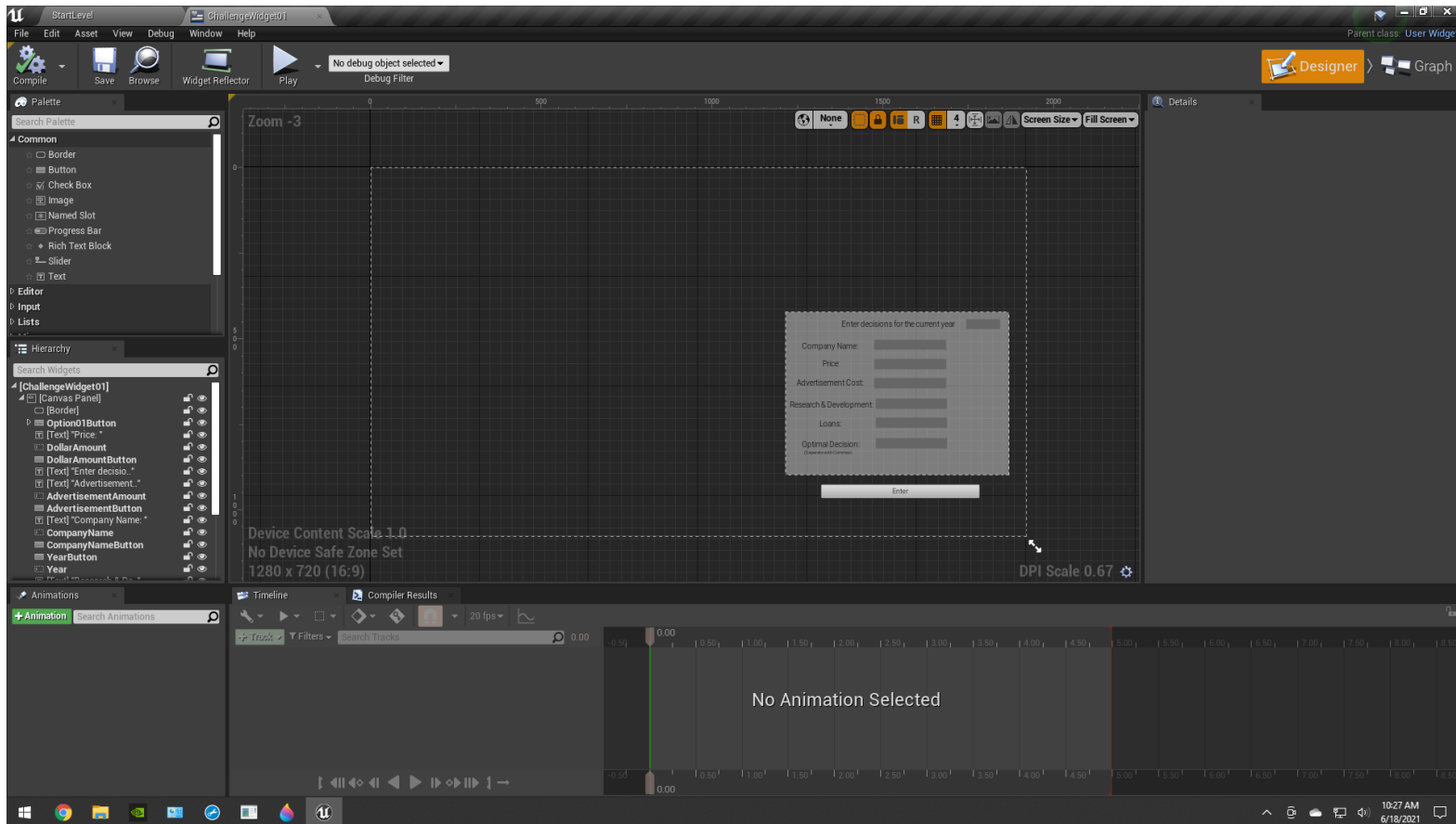


Figure 45 Unreal Engine allows one to create the HUDs, or Heads Up Display, which allows the questions to be shown to the user so they may make decisions which are provided.

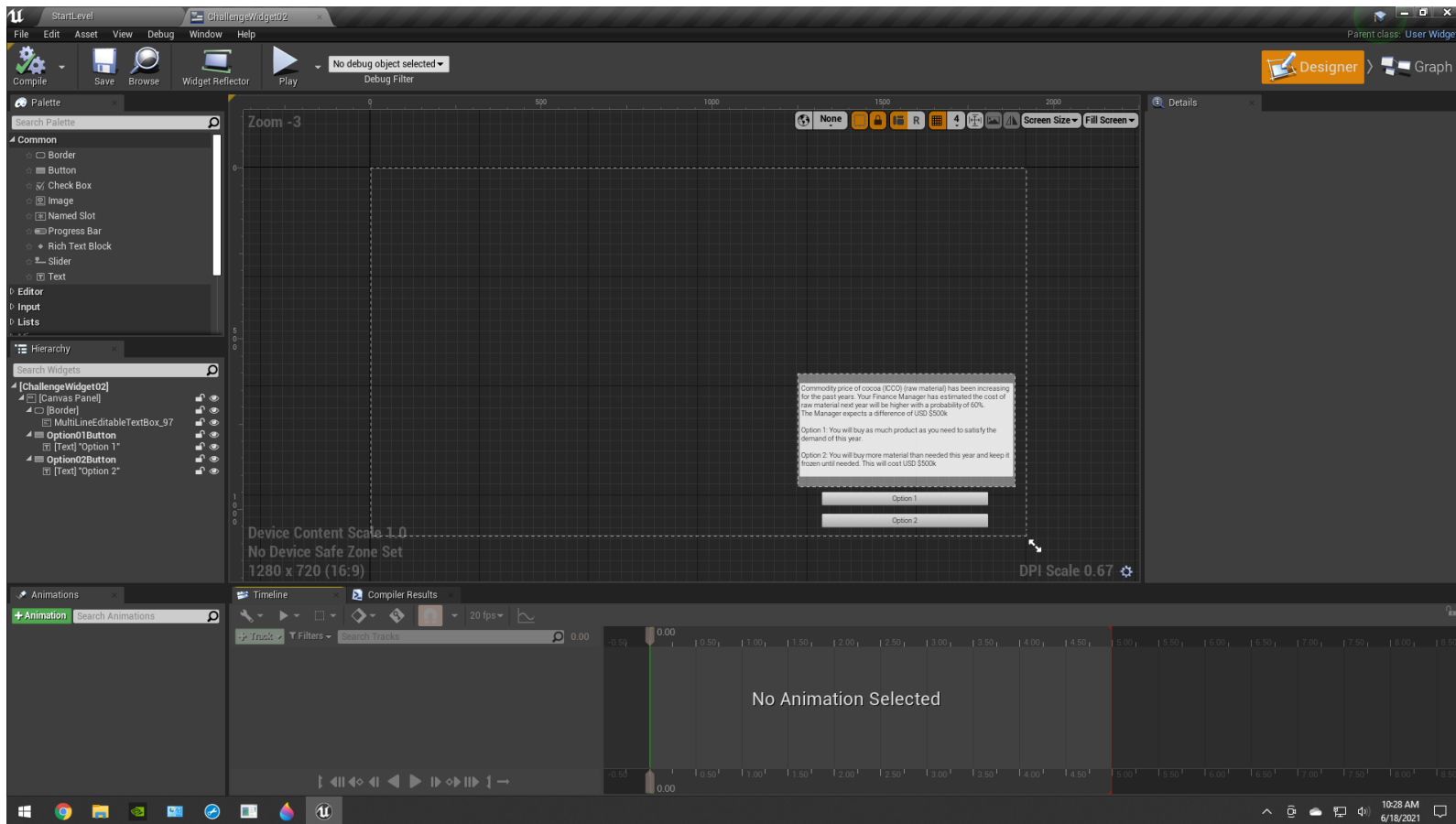


Figure 46 Unreal Engine allows one to create the HUDs, or Heads Up Display, which allows the questions to be shown to the user so they may make decisions which are provided.

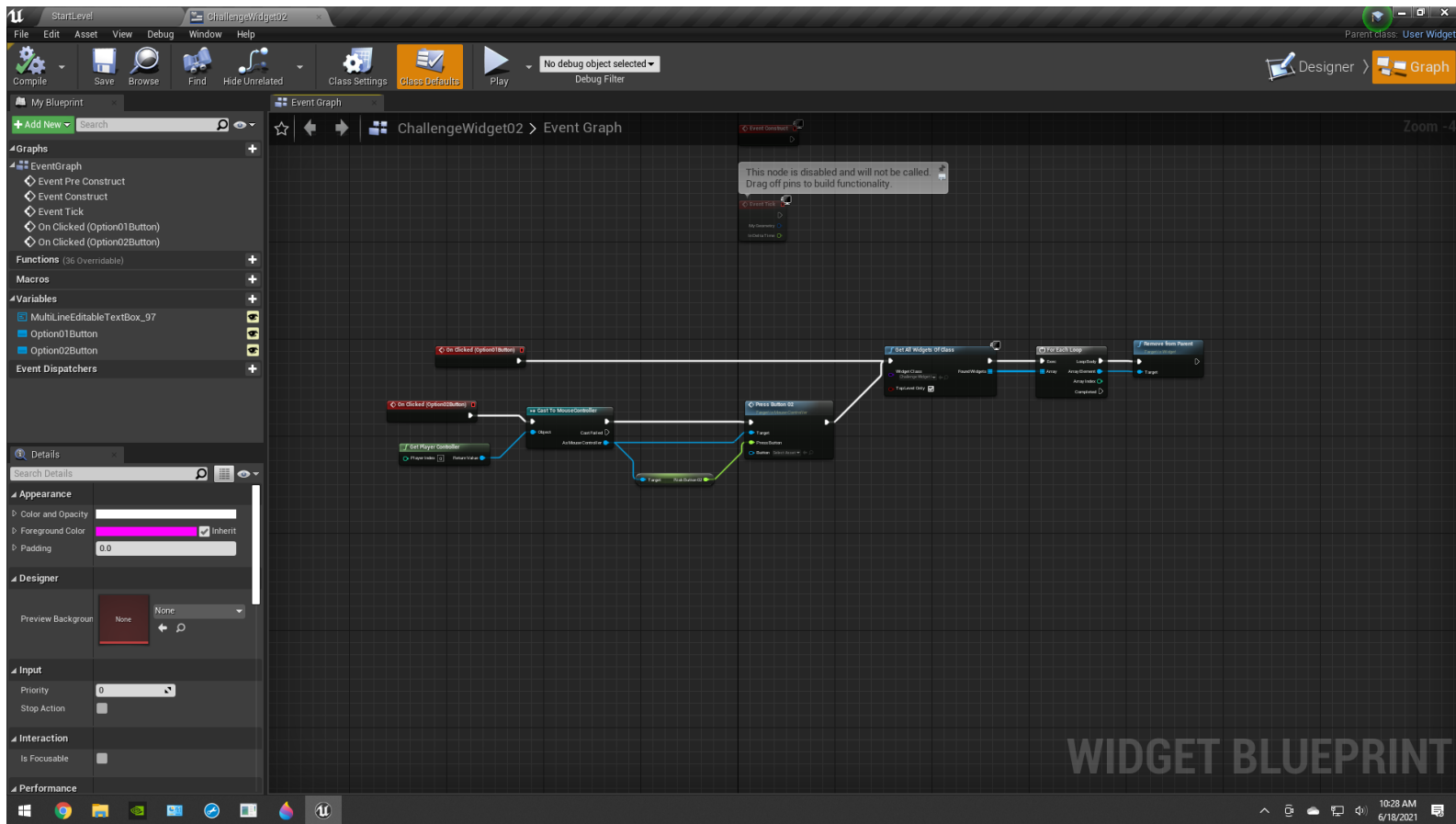


Figure 47 Unreal Engine allows one to create the HUDs, or Heads Up Display, which allows the questions to be shown to the user so they may make decisions which are provided.

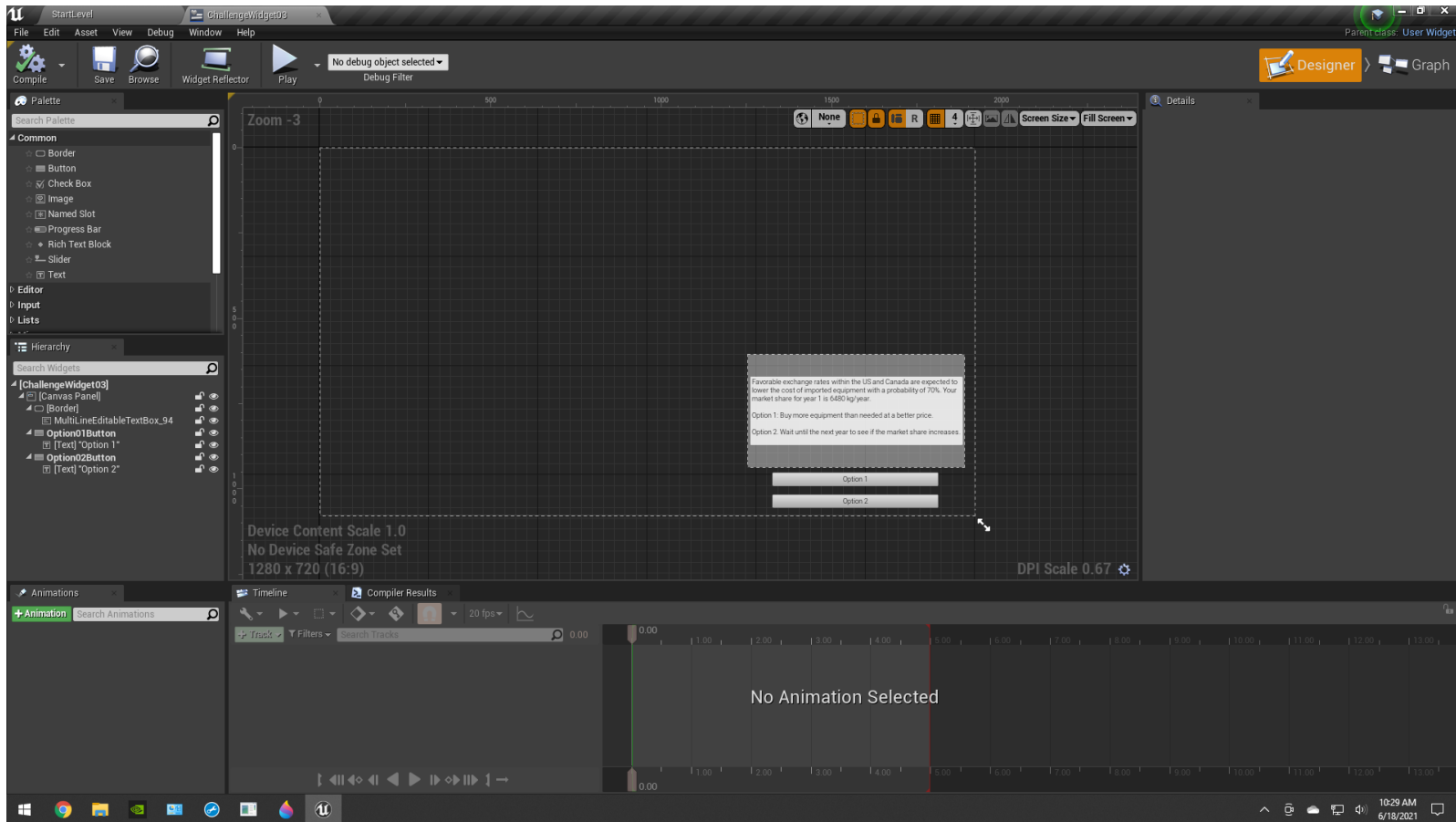


Figure 48 Unreal Engine allows one to create the HUDs, or Heads Up Display, which allows the questions to be shown to the user so they may make decisions which are provided.

Appendix B. Certification of Approval Human Research Ethics

Certificate of Approval - Annual Renewal

PRINCIPAL INVESTIGATOR	Alex Thomo (Supervisor)	ETHICS PROTOCOL NUMBER	19-0127
PRINCIPAL APPLICANT	Olga Gould Master's student	Expedited review - delegated	
UVIC DEPARTMENT	Computer Science COSI	ORIGINAL APPROVAL DATE	07-May-2019
		APPROVED ON	23-Apr-2021
		APPROVAL EXPIRY DATE	06-May-2022

PROJECT TITLE **Realistic Approach and Automatization of Management Simulation Games Focused on Improving Entrepreneurship Outcomes for Users.**

RESEARCH TEAM MEMBERS **None**

DECLARED PROJECT FUNDING **None**

DOCUMENTS INCLUDED IN THIS APPROVAL
 1 contract-Olga Gould VIRCS.pdf - 06-Mar-2019
 Copy of Workers Business Magazine Cover.jpg - 06-Mar-2019
 PTest-MBTI.pdf - 06-Mar-2019
 info_letter_template_olgagould.doc - 17-Apr-2019
 Business Simulation Game Evaluation Form.docx - 05-May-2019
 Instructional Contract between VICRS and Olga Gould.pdf - 01-Oct-2019
 part 2 poster.png - 01-Oct-2019
 SDI test Strengths Deployment Inventory.docx - 01-Oct-2019
 Courses thought by Olga Gould 2019-2021.xlsx - 22-Apr-2021

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
 To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
 Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
 When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlines by the University of Victoria Research Regulations Involving Human Participants.